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(71) Applicant (for all designated States except US): PFIZER INC. [US/US]; 235 East 42nd Street, New York, NY 10017 (US).			
(72) Inventor; and (75) Inventor/Applicant (for US only): KLEINMAN, Edward, F. [US/US]; 16 Roseridge Court, Pawcatuck, CT 06379 (US).			
(74) Agents: SPIEGEL, Allen, J. et al.; Pfizer Inc., Patent Dept., 235 East 42nd Street, New York, NY 10017 (US).			

(54) Title: **3-ARYL-2-ISOXAZOLINES AS ANTIINFLAMMATORY AGENTS**

(57) Abstract

This invention relates to 3-aryl-2-isoxazoline compounds which are selective inhibitors of phosphodiesterase type IV (PDEIV). The 3-aryl-2-isoxazolines are useful in the treatment of AIDS, asthma, arthritis, bronchitis, chronic obstructive pulmonary disease, psoriasis, allergic rhinitis, dermatitis, shock, atopic dermatitis, rheumatoid arthritis and osteoarthritis. This invention also relates to pharmaceutical compositions useful therefor.

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3-ARYL-2-ISOXAZOLINES AS ANTIINFLAMMATORY AGENTS

Background of the Invention

This Invention relates to a series of 3-aryl-2-isoxazoline compounds which are 5 selective inhibitors of phosphodiesterase (PDE) type IV and as such are useful in the treatment of AIDS, asthma, arthritis, bronchitis, chronic obstructive airways disease, psoriasis, allergic rhinitis, dermatitis and other inflammatory diseases.

This Invention also relates to the pharmaceutically acceptable salts of said compounds; to a method of using such compounds in inhibiting PDE_{IV}, the treatment 10 of inflammatory conditions and the treatment of AIDS, asthma, arthritis, bronchitis, chronic obstructive airways disease, psoriasis, allergic rhinitis and dermatitis in mammals, especially humans; and to pharmaceutical compositions useful therefor.

The "inflammatory conditions" which can be treated according to this Invention include, but are not limited to, chronic obstructive pulmonary disease, septic shock, 15 atopic dermatitis, bronchitis, rheumatoid arthritis and osteoarthritis.

Since the recognition that cyclic AMP is an intracellular second messenger (E. W. Sutherland, and T. W. Rall, Pharmacol. Rev., 1960, 12, 265), inhibition of the phosphodiesterases has been a target for modulation and, accordingly, therapeutic intervention in a range of disease processes. More recently, distinct classes of PDE 20 have been recognized (J. A. Beavo and D. H. Reifsnyder, TIPS, 1990, 11, 150), and their selective inhibition has led to improved drug therapy (C. D. Nicholson, R. A. Challiss and M. Shahid, TIPS, 1991, 12, 19). More particularly, it has been recognized that inhibition of PDE_{IV} can lead to inhibition of inflammatory mediator release (M. W. Verghese et al., J. Mol. Cell Cardiol., 1989, 12 (Suppl. II), S 61) and airway smooth 25 muscle relaxation (T. J. Torphy in Directions for New Anti-Asthma Drugs, eds S. R. O'Donnell and C. G. A. Persson, 1988, 37, Birkhauser-Verlag). Thus, compounds that inhibit PDE_{IV}, but which have poor activity against other PDE types, would inhibit the release of inflammatory mediators and relax airway smooth muscle without causing cardiovascular effects or antiplatelet effects.

30 Certain Isoxazoline phosphonic acid compounds are disclosed to be useful for the treatment of diseases of the immune system in United States Patent Number 5,006,515.

Certain catechol diethers are disclosed to be useful as PDE_{IV} inhibitors and as such are useful in the treatment of inflammatory diseases, AIDS, asthma, arthritis,

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bronchitis, chronic obstructive airways disease, psoriasis, allergic rhinitis and dermatitis, in copending United States patent application, Serial No. 07/984,408 filed December 2, 1992, which application is assigned to the assignee hereof.

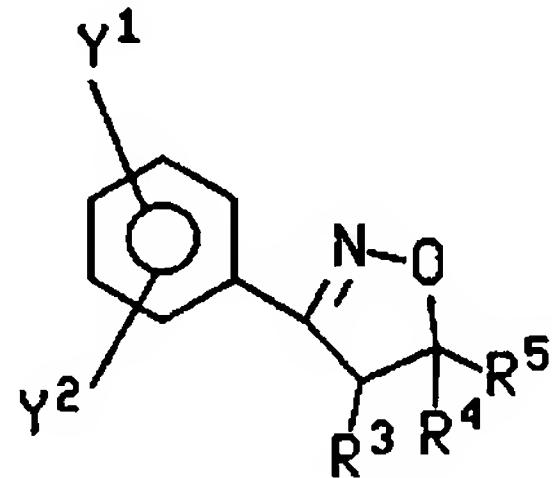
Certain pyrimidone compounds have been disclosed to be useful as antidepressants by Saccamano et al., in European Patent Application EPO 247 725 A2. The same pyrimidone compounds have been disclosed to be useful against asthma and certain skin disorders in International Patent Application No. PCT/US90/02162, published May 30, 1991 as International Publication Number WO 91/07178.

Summary of the Invention

10 This invention is concerned with a series of 3-aryl-2-isoxazoline compounds and to the pharmaceutically acceptable salts of such compounds. These new compounds are selective inhibitors of PDE_{IV}, and as such are useful in the treatment of inflammatory conditions, AIDS, asthma, arthritis, bronchitis, chronic obstructive airways disease, psoriasis, allergic rhinitis and dermatitis in mammals, especially humans.

15 The compounds of the present invention are of the formula (I)

20



(I)

the racemic, racemic-diastereomeric mixtures and optical isomers of said compounds
25 and the pharmaceutically acceptable salts thereof wherein

Y¹ and Y² are independently selected from the group consisting of hydrogen, (C₁-C₆)alkyl, optionally substituted phenylalkyl having 1 to 6 carbons in the alkyl portion, optionally substituted phenoxyalkyl having 1 to 6 carbons in the alkyl portion, (C₃-C₇)cycloalkyl, fluoro, chloro, bromo, iodo, -OR¹ and -OR²;

30 wherein the aromatic portion of the optionally substituted phenylalkyl, and the aromatic portion of the optionally substituted phenoxyalkyl are optionally independently substituted with (C₁-C₄)alkyl, (C₁-C₄)alkoxy, halogen or CF₃;

R¹ is alkyl having 1 to 3 carbons, fluoromethyl, difluoromethyl or trifluoromethyl;

R² is (C₁-C₃)alkyl, (C₃-C₇)cycloalkyl, alkoxyalkyl having 3 to 7 carbons in the

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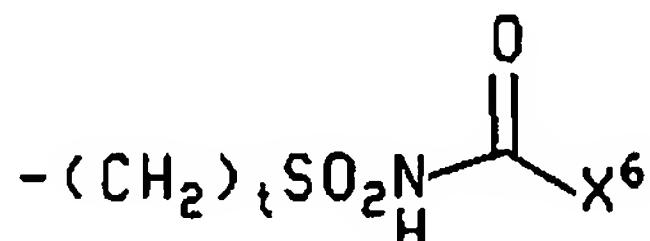
alkoxy portion and 2 to 4 carbons in the alkyl portion, optionally substituted phenoxyalkyl having 2 to 6 carbons in the alkyl portion, optionally substituted phenylalkyl having 1 to 6 carbons in the alkyl portion, bicycloalkyl having 6 to 9 carbons or optionally substituted indanyl;

5 wherein the aromatic portion of the optionally substituted phenylalkyl, the aromatic portion of the optionally substituted phenoxyalkyl and the optionally substituted Indanyl are optionally independently substituted with (C₁-C₄)alkyl, (C₁-C₄)alkoxy, halogen or CF₃;

R³ is hydrogen, (C₁-C₃)alkyl, mono-hydroxyalkyl having 1 to 3 carbons or alkoxyalkyl having 1 to 3 carbons in the alkyl portion and 1 to 3 carbons in the alkoxy portion;
 10 R⁴ is hydrogen, (C₁-C₅)alkyl, -COOH, alkoxyalkyl having 1 to 3 carbons in the alkyl portion and 1 to 3 carbons in the alkoxy portion, N-alkylaminoalkyl having 1 to 3 carbons in the alkylamino portion and 1 to 3 carbons in the alkyl portion or N,N-dialkylaminoalkyl having a total of 2 to 6 carbons in the dialkylamino portion and 1 to
 15 3 carbons in the alkyl portion;
 or R³ and R⁴ are taken together with the carbon atoms to which they are attached and form -CH₂OCH₂OCH₂-; and
 R⁵ is hydrogen, -CHO, amino, aminoalkyl having 1 to 3 carbons,



20 -COR⁷, -(CH₂)_mCO₂H, (C₁-C₄)alkyl, hydroxy, -(CH₂)_qCONX²X³, -(CH₂)_rSO₂NX⁴X⁵,
 -(CH₂)_sPO₃H₂ or



wherein b is 0 or an integer from 1 to 6;

m, n, q, r, s and t are independently 0, 1, 2, 3 or 4;

25 R⁶ and R⁷ are each independently (C₁-C₄)alkyl;

X¹ is hydrogen, (C₁-C₄)alkyl, -O(C₁-C₄)alkyl or alkoxyphenyl having one to four carbon atoms in the alkoxy portion;

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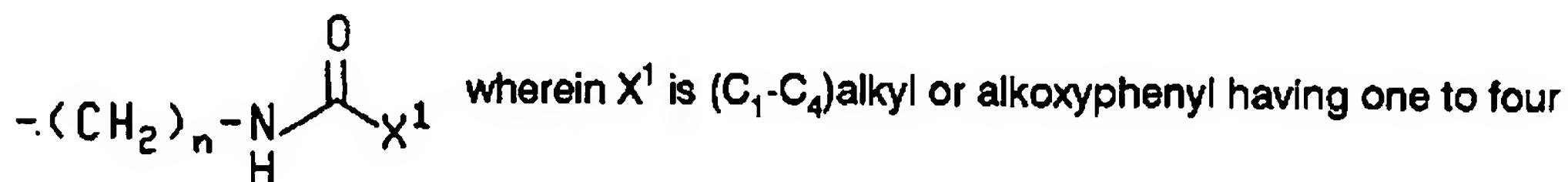
X^2 , X^3 , X^4 and X^5 are each independently hydrogen or (C_1-C_3) alkyl; and
 X^6 is (C_1-C_3) alkyl or phenyl;

provided that when R^1 is (C_1-C_3) alkyl, R^2 is (C_1-C_3) alkyl, R^3 is hydrogen, and R^4 is hydrogen then R^5 is not $-(CH_2)_sPO_3H_2$; and

- 5 when R^4 is -COOH then R^5 is not -COOH; and that
both Y^1 and Y^2 cannot be hydrogen at the same time.

A preferred group of compounds or the pharmaceutically acceptable salts thereof of this invention are those compounds of the formula (I) wherein Y^1 is -OR¹ and is attached to the 4-position of the phenyl ring and Y^2 is -OR² and is attached to the 3-position of the phenyl ring.

A more preferred group of compounds or the pharmaceutically acceptable salts thereof of this invention are those compounds of the formula (I) wherein Y^1 is -OR¹ and is attached to the 4-position of the phenyl ring and Y^2 is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is (C_3-C_7) cycloalkyl, bicycloalkyl having 6 to 9 carbons, or phenylalkyl having 1 to 6 carbons in the alkyl portion; R³ is hydrogen or (C_1-C_3) alkyl; R⁴ is hydrogen or (C_1-C_5) alkyl; and R⁵ is $-(CH_2)_mCO_2H$, -CHO, -COCH₃, amino, hydroxy, mono-hydroxyalkyl having 1 to 3 carbons, aminoalkyl having 1 to 3 carbons, or



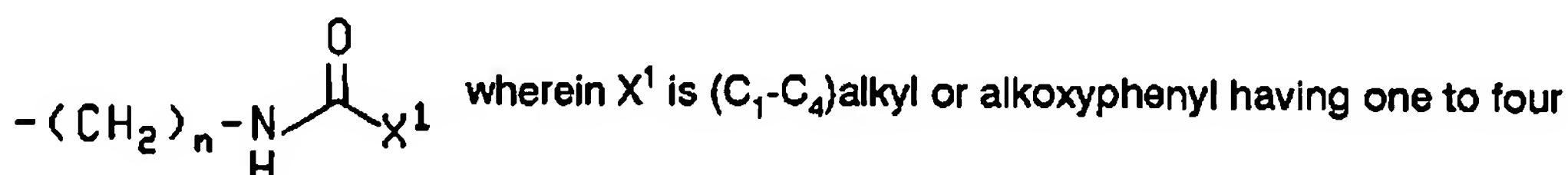
- 20 carbon atoms in the alkoxy portion and n is 0 or an integer from 1 to 3.

Another more preferred group of compounds or the pharmaceutically acceptable salts thereof are those compounds of the formula (I) wherein Y^1 is -OR¹ and is attached to the 4-position of the phenyl ring and Y^2 is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is 5-phenylpentyl; R³ is hydrogen; R⁴ is hydrogen or CH₃ and R⁵ is $-(CH_2)_sPO_3H_2$ wherein s is 0 or 1.

Further, another more preferred group of compounds or the pharmaceutically acceptable salts thereof are those compounds of the formula (I) wherein Y^1 is -OR¹ and is attached to the 4-position of the phenyl ring and Y^2 is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is cyclopentyl; R³ is hydrogen; R⁴ is hydrogen and R⁵ is $-(CH_2)_sPO_3H_2$ wherein s is 0.

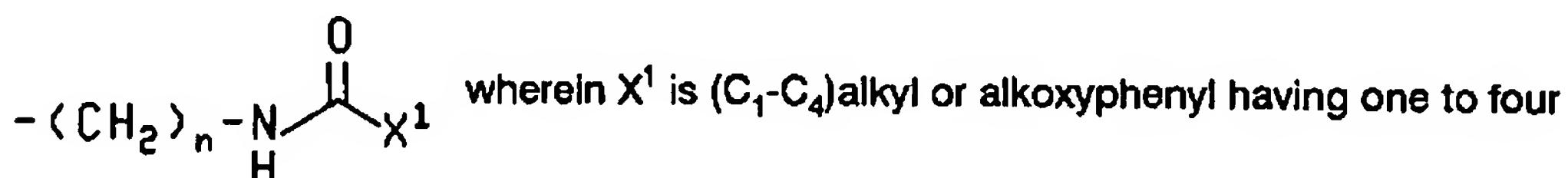
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Furtherstill, another more preferred group of compounds or the pharmaceutically acceptable salts thereof are those compounds of the formula (I) wherein Y¹ is -OR¹ and is attached to the 4-position of the phenyl ring and Y² is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl, R² is 4-phenylbutyl, 5-phenylpentyl or 5 cyclopentyl, R³ is hydrogen or (C₁-C₃)alkyl; R⁴ is hydrogen or (C₁-C₅)alkyl; and R⁵ is -(CH₂)_mCO₂H, -CHO, -COCH₃, amino, hydroxy, mono-hydroxyalkyl having 1 to 3 carbons, aminoalkyl having 1 to 3 carbons, or



10 carbon atoms in the alkoxy portion and n is 0 or an integer from 1 to 3.

Yet another more preferred group of compounds or the pharmaceutically acceptable salts thereof are those compounds of the formula (I) wherein Y¹ is -OR¹ and is attached to the 4-position of the phenyl ring and Y² is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is 5-phenylpentyl; R³ is hydrogen or (C₁-C₃)alkyl; R⁴ is hydrogen or (C₁-C₅)alkyl and R⁵ is -(CH₂)_mCO₂H, -CHO, -COCH₃, amino, hydroxy, mono-hydroxyalkyl having 1 to 3 carbons, aminoalkyl having 1 to 3 carbons, or



20 carbon atoms in the alkoxy portion and n is 0 or an integer from 1 to 3.

Yet still another more preferred group of compounds or the pharmaceutically acceptable salts thereof are those compounds of the formula (I) wherein Y¹ is -OR¹ and is attached to the 4-position of the phenyl ring and Y² is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is 5-phenylpentyl; R³ is hydrogen or (C₁-C₃)alkyl; R⁴ is hydrogen or (C₁-C₅)alkyl and R⁵ is -(CH₂)_mCO₂H, -CHO, -COCH₃, hydroxy or mono-hydroxyalkyl having 1 to 3 carbons.

A most preferred group of compounds or the pharmaceutically acceptable salts

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thereof are those compounds of the formula (I) wherein Y¹ is -OR¹ and is attached to the 4-position of the phenyl ring and Y² is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is 5-phenylpentyl; R³ is hydrogen or (C₁-C₃)alkyl; R⁴ is hydrogen or (C₁-C₅)alkyl and R⁵ is -(CH₂)_mCO₂H.

5 Yet still another most preferred group of compounds or the pharmaceutically acceptable salts thereof are those compounds of the formula (I) wherein Y¹ is -OR¹ and is attached to the 4-position of the phenyl ring and Y² is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is 5-phenylpentyl; R³ is hydrogen; R⁴ is hydrogen or (C₁-C₅)alkyl and R⁵ is -(CH₂)_mCO₂H wherein m=0.

10 A particularly preferred group of compounds or the pharmaceutically acceptable salts thereof are those compounds of the formula (I) wherein Y¹ is -OR¹ and is attached to the 4-position of the phenyl ring and Y² is -OR² and is attached to the 3-position of the phenyl ring, wherein R¹ is methyl; R² is 5-phenylpentyl; R³ is hydrogen; R⁴ is hydrogen, methyl, ethyl or propyl and R⁵ is -(CH₂)_mCO₂H wherein m=0.

15 Most particularly preferred compounds of this invention are (+) or (-)-5-ethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline-5-carboxylic acid. Of the two, (-)-5-ethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]-phenyl-2-isoxazoline-5-carboxylic acid is the more preferred compound.

The term alkyl encompasses both straight and branched chains. The aromatic portion of the optionally substituted phenylalkyl, the aromatic portion of the optionally substituted phenoxyalkyl and the optionally substituted indanyl may be substituted by one or more substituents.

Detailed Description of the Invention

The compounds of the present invention having the formula (I) are comprised of the racemic, racemic-diastereomeric mixtures and optical isomers of said compounds and the pharmaceutically acceptable salts thereof. The compounds of the present invention, having the formula I as defined above, are readily and generally prepared by the following reaction processes.

Compounds of the formula (I) wherein R⁵ is a carboxylic acid can be synthesized by mixing a methanol solution of the corresponding alkyl ester, wherein R⁵ is ethyl ester, with an aqueous solution of an inorganic base such as KOH. The mixture is stirred at room temperature until the reaction is substantially complete. The reaction mixture is worked-up according to methods well-known to those skilled in the art.

Compounds of the formula (I) wherein R⁵ is carboxymethyl (-CH₂CO₂H) are

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synthesized by reacting a compound of the formula (I) wherein R⁵ is hydroxymethyl (-CH₂OH) with p-toluenesulfonyl chloride in the presence of a tertiary amine such as triethylamine in an inert solvent at 0°C to 50°C to give a compound of the formula (I) wherein R⁵ is -CH₂OTs, which is reacted with lithium, sodium or potassium cyanide in 5 an inert solvent such as DMSO at 0°C to 100°C to give a compound of the formula (I) wherein R⁵ is -CH₂CN, which is hydrolyzed with an inorganic base such as KOH in water and an alcoholic solvent at room temperature to 100°C.

The compounds of formula (I) wherein R⁵ is an aldehyde can be synthesized by dissolving the corresponding compound of formula (I) wherein R⁵ is -CONH-alkyl in a 10 dry inert solvent such as tetrahydrofuran, decreasing the temperature of the solution to between -65° to -78°C and then adding dropwise 3 to 5 equivalents of diisobutylaluminum hydride (DIBAL-H) in hexane. The reaction mixture is maintained at about -78°C for about 30 to 60 minutes and then allowed to warm to room 15 temperature. The reaction mixture is worked-up according to methods well known to those skilled in the art. The resulting aldehyde compound can be optionally reduced to obtain the corresponding alcohol. The aldehyde compound is dissolved in an alcoholic solvent and treated with sodium borohydride; the mixture is stirred at room temperature until the reaction is substantially complete.

Compounds of the formula (I) wherein R⁵ is hydroxy can be synthesized by 20 dissolving the corresponding acyloxy derivative, such as when R⁵ is -OCOCH₃, in an alcoholic solvent and treating the solution with approximately 1.1 equivalents of sodium methoxide. The reaction mixture is stirred at room temperature until the reaction is substantially complete, which is usually about 1 hour.

Compounds of the formula (I) wherein R⁵ is a mono-hydroxyalkyl, are 25 synthesized by reducing the corresponding ester, wherein R⁵ is an alkyl ester, with diisobutylaluminum hydride (DIBAL-H) according to the following procedure. A compound of formula (I) wherein R⁵ is a methyl or ethyl ester, is dissolved in THF and chilled to about -78°C. Approximately 2 to 4 equivalents of DIBAL-H in hexane is added to the cold THF mixture. The solution is warmed to about -30°C and then quenched 30 with a dilute solution of HCl.

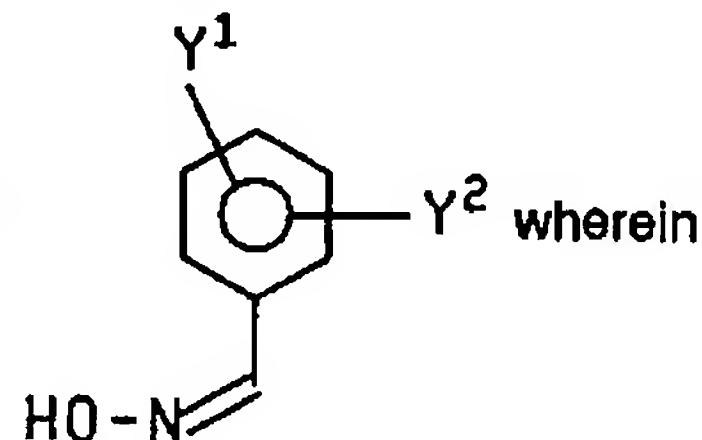
Alternatively, the compounds of formula (I) wherein R⁵ is hydroxymethyl, are synthesized by reducing a compound of formula (I) wherein R⁵ is an aldehyde. The aldehyde compound is dissolved in an alcoholic solvent and treated with sodium borohydride; the mixture is stirred at room temperature until the reaction is substantially

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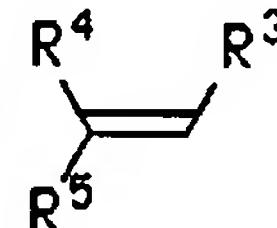
complete. Further, the compounds of formula (I) wherein R⁵ is a 1-hydroxyalkyl (i.e., -CH(OH)alkyl) are synthesized by reducing a corresponding compound of formula (I) wherein R⁵ is a ketone moiety (i.e., -COalkyl) according to the following procedure. The ketone compound of formula (I) is dissolved in an alcoholic solvent and cooled to about 5 0°C, to which is added sodium borohydride. The mixture is stirred until the bubbling ceases and then stirred at room temperature for approximately 1 hour.

Certain compounds of the formula (I) are synthesized according to the following procedure. To a mixture of N-chlorosuccinimide and pyridine in an inert solvent, such

as methylene chloride, is added an oxime of the formula

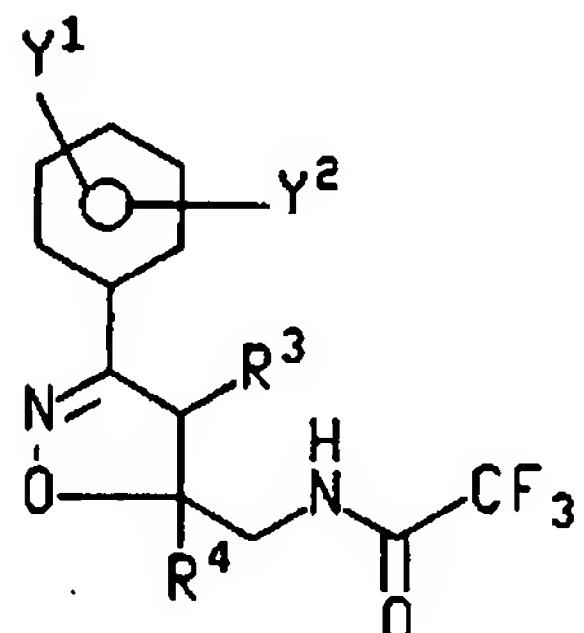


10 Y¹ and Y² are as defined above for formula (I). The mixture is allowed to stir for about
2 to 5 hours, preferably about 2 hours. A compound of the formula



wherein R³, R⁴ and R⁵ are as defined above for formula I, is added followed by the addition of triethylamine to the mixture and the mixture stirred for about 2 hours more at room temperature. The reaction is worked up according to methods well known to
15 those skilled in the art.

Compounds of the formula (I) wherein R⁵ is aminomethyl are synthesized according to the following procedure. A compound of the formula

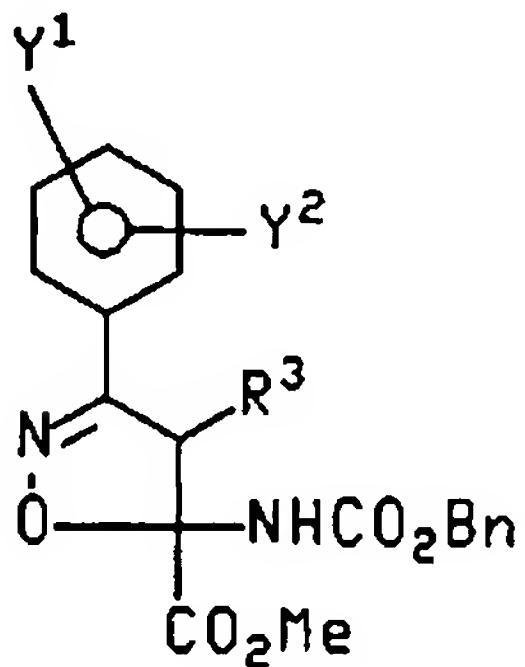


wherein Y¹, Y², R³ and R⁴ are as defined above for formula (I),

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is dissolved in a mixture of methanol and water. An inorganic base such as KOH is added to the mixture and the reaction mixture is allowed to stir at room temperature for about 12 to 24 hours, preferably 16 hours. The reaction is worked-up according to methods well-known to those skilled in the art.

5 Compounds of the formula (I) wherein R⁴ is -COOH and R⁵ is an amino group are synthesized according to the following procedure. A compound of the formula



wherein Y¹, Y² and R³ are as defined above for formula (I), is

reacted with bromotrimethylsilane for about 12 to 24 hours, preferably 16 hours. Acetonitrile is added, for solubility if necessary, to the reaction mixture and the mixture
10 is heated to reflux until the reaction is substantially complete. The reaction is worked-up according to methods well-known to those skilled in the art.

Compounds of formula (I) wherein R⁵ is -(CH₂)₆PO₃H₂ are synthesized according to the following procedure. A solution of the appropriate phosphonate dissolved in trimethylsilyl bromide is stirred for about 2 hours at room temperature. The mixture is
15 evaporated and the residue is diluted with H₂O and an organic solvent such as CH₂Cl₂ and stirred for about 2 hours. The mixture is filtered and the aqueous layer is basified with an aqueous inorganic base such as 1N NaOH. The organic layer is discarded and the aqueous layer is washed with additional organic solvent such as CH₂Cl₂. The aqueous layer is acidified and extracted with an organic solvent such as EtOAc.
20 Evaporating the EtOAc yields the desired compound.

The synthetic methods outlined above together with the following examples describe methods which were and can be employed to prepare the compounds of this invention.

As ascertained by one skilled in the art enabled by this disclosure,

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pharmaceutically-acceptable acid addition salts of certain compounds of this invention include, but are not limited to, those formed with HCl, HBr, HNO₃, H₂SO₄, H₃PO₄, CH₃SO₃H, p-CH₃C₆H₄SO₃H, CH₃CO₂H, gluconic acid, tartaric acid, maleic acid and succinic acid. In the case of those compounds of the formula (I) which contain a further 5 basic nitrogen, it will, of course, be possible to form diacid addition salts (e.g., the dihydrochloride) as well as the usual monoacid addition salt. As ascertained by one skilled in the art enabled by this disclosure, pharmaceutically-acceptable cationic salts of certain compounds of this invention include, but are not limited to, those of sodium, potassium, calcium, magnesium, ammonium, N,N'-dibenzylethylenediamine, N-10 methylglucamine (meglumine), ethanolamine and diethanolamine.

The starting materials and reagents required for the synthesis of the compounds of the present invention are readily available, either commercially, according to literature methods, or by methods exemplified in Preparations below.

The ability of the compounds or the pharmaceutically acceptable salts thereof 15 to inhibit PDE_{IV} and, consequently, demonstrate their effectiveness for treating inflammatory diseases is shown by the following in vitro assay.

BIOLOGICAL ASSAY

(Human lung PDE_{IV})

Thirty to forty grams of human lung tissue is placed in 50 ml of pH 7.4 20 Tris/phenylmethylsulfonyl fluoride (PMSF)/sucrose buffer and homogenized using a Tekmar Tissumizer® (Tekmar Co., 7143 Kemper Road, Cincinnati, Ohio 45249) at full speed for 30 seconds. The homogenate is centrifuged at 48,000 x g for 70 minutes at 4°C. The supernatant is filtered twice through a 0.22 µm filter and applied to a Mono-Q 25 FPLC column (Pharmacia LKB Biotechnology, 800 Centennial Avenue, Piscataway, New Jersey 08854) pre-equilibrated with pH 7.4 Tris/PMSF buffer. A flow rate of 1 ml/minute is used to apply the sample to the column, followed by a 2 ml/minute flow rate for subsequent washing and elution. Sample is eluted using an increasing, step-wise NaCl gradient in the Ph 7.4 Tris/PMSF buffer. Eight ml fractions are collected. Fractions are assayed for specific PDE_{IV} activity, determined by [³H]cAMP hydrolysis and the ability 30 of a known PDE_{IV} inhibitor (e.g. rolipram) to inhibit that hydrolysis. Appropriate fractions are pooled, diluted with ethylene glycol (2 ml ethylene glycol/5 ml of enzyme prep) and stored at -20°C until use.

Compounds are dissolved in DMSO at a concentration of 10 mM and diluted 1:25 in water (400 µM compound, 4% DMSO). Further serial dilutions are made in 4%

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DMSO to achieve desired concentrations. Final DMSO concentration in the assay tube is 1%. In duplicate the following are added, in order, to a 12 x 75 mm glass tube (all concentrations are given as final concentrations in assay tube).

- i) 25 µl compound or DMSO (1%, for control and blank)
- 5 ii) 25 µl pH 7.5 Tris buffer
- iii) [³H]cAMP (1 µM)
- iv) 25 µl PDE_{IV} enzyme (for blank, enzyme is preincubated in boiling water for 5 minutes)

The reaction tubes are shaken and placed in a water bath (37°C) for 20 minutes, at which time the reaction is stopped by placing the tubes in a boiling water bath for 4 minutes. Washing buffer (0.5 ml, 0.1M 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (HEPES)/0.1M NaCl, pH 8.5) is added to each tube on an ice bath. The contents of each tube are applied to an Affi-Gel 601 column (Biorad Laboratories, P.O. Box 1229, 85A Marcus Drive, Melville, New York 11747) (boronate affinity gel, 1 ml bed volume) previously equilibrated with washing buffer. [³H]cAMP is washed with 2 x 6 ml washing buffer, and [³H]5'AMP is then eluted with 4 ml of 0.25M acetic acid. After vortexing, 1 ml of the elution is added to 3 ml of scintillation fluid in a suitable vial, vortexed and counted for [³H].

% Inhibition is determined by the formula:

20 % Inhibition = $\frac{1 - \frac{\text{average cpm (test compound)} - \text{average cpm (blank)}}{\text{average cpm (control)} - \text{average cpm (blank)}}}{\times 100}$

IC₅₀ is defined as that concentration of compound which inhibits 50% of specific hydrolysis of [³H]cAMP to [³H]5'AMP.

For administration to humans to inhibit PDE_{IV} in the treatment of inflammatory conditions, AIDS, asthma, arthritis, bronchitis, chronic obstructive airways disease, psoriasis, allergic rhinitis, dermatitis and other inflammatory diseases, oral dosages of the compounds are generally in the range of from 0.1-500 mg daily for an average adult patient (70 kg). Thus for a typical adult patient, individual tablets or capsules contain from 0.1 to 50 mg of active compound, in a suitable pharmaceutically acceptable vehicle or carrier. Tablets or capsules can be given in multiple dosages to meet the dosage requirement. Dosages for intravenous administration are typically within the range of 0.1 to 10 mg per single dose as required. For intranasal or inhaler administration, the dosage is generally formulated as a 0.1 to 1% (w/v) solution. In practice the physician will determine the actual dosage which will be most suitable for

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an individual patient and it will vary with the age, weight and response of the particular patient. The above dosages are exemplary of the average case but there can, of course, be individual instances where higher or lower dosage ranges are merited, and all such dosages are within the scope of this invention.

5 For human use, the compounds of the formula (I) can be administered alone, but will generally be administered in an admixture with a pharmaceutical diluent or carrier selected with regard to the intended route of administration and standard pharmaceutical practice. For example, they may be administered orally in the form of tablets containing such excipients as starch or lactose, or in capsules or ovales either
10 alone or in admixture with excipients, or in the form of elixirs or suspensions containing flavoring or coloring agents. They may be injected parenterally; for example, intravenously, intramuscularly or subcutaneously. For parenteral administration, they are best used in the form of a sterile aqueous solution which may contain other substances; for example, enough salts or glucose to make the solution isotonic. For
15 topical administration, they are best used in the form of solutions, lotions, ointments, salves and the like.

Thus in a further aspect the invention provides pharmaceutical compositions comprising a compound of the formula (I), or pharmaceutically acceptable salts thereof, together with a pharmaceutically acceptable diluent or carrier.

20 This invention provides a method of inhibiting PDE_{IV} in a mammal in need thereof which method comprises administering to said mammal an effective amount of a compound of the formula (I) or a pharmaceutically acceptable salt thereof.

25 This invention further provides a method of treating an inflammatory condition in a mammal in need thereof which comprises administering to said mammal an antiinflammatory amount of a compound of the formula (I) or a pharmaceutically acceptable salt thereof.

30 Further still, this invention provides a method of treating AIDS, asthma, arthritis, bronchitis, chronic obstructive pulmonary disease, psoriasis, allergic rhinitis, dermatitis or shock in a mammal in need thereof which comprises administering to said mammal an effective amount of a compound or a pharmaceutically acceptable salt thereof.

The present invention is illustrated by the following examples, but it is not limited to the details thereof.

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EXAMPLE 1

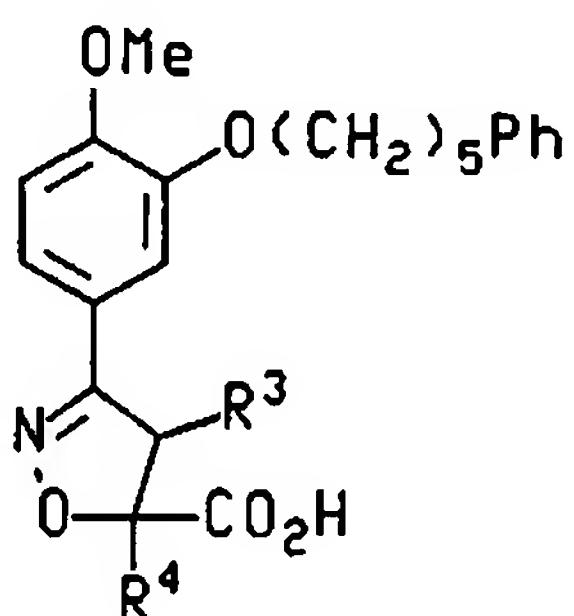
3-[4-Methoxy-3-(5-phenylpentyloxy)phenyl]-2-isoxazoline-5-carboxylic Acid

To a mixture of 1.00 g (2.43 mmol) of the compound of Preparation 15, 15 ml of MeOH, and 5 ml of water was added 273 mg (4.86 mmol) of KOH. The mixture was stirred overnight at RT and was then partially evaporated to remove MeOH. The residue was diluted with water to a volume of 125 ml, acidified with 6N HCl solution, and extracted with EtOAc (2 x 125 ml). The combined extracts were dried (Na_2SO_4) and evaporated to give 729 mg (78%) of the title compound as an oil. ^1H NMR (CDCl_3): δ 1.44-1.94 (6H, m), 2.64 (2H, t), 3.66-3.70 (2H, m), 3.89 (3H, s), 4.02 (2H, q, $J=7$), 5.18 (1H, t, $J=10$), 6.83 (1H, d, $J=8$), 7.02 (1H, dd, $J=8, 2$), 7.11-7.31 (6H, m). FABMS (m/e): 384 ($M^+ + 1$).

EXAMPLES 2 - 5

The following compounds were prepared substantially according to the procedure of Example 1.

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Example	Ester	R^4	R^3	M.P. °C	Data
2	Compound of Preparation 16	Me	H	101-103	^1H NMR (CDCl_3): δ 1.40-1.88 (6H, m), 1.72 (3H, s), 2.58 (2H, t, $J=7$), 3.23 (1H, d, $J=16$), 3.78 (1H, d, $J=16$), 3.93 (3H, s), 3.96 (2H, q, $J=7$), 6.76 (1H, d, $J=8$), 6.93 (1H, dd, $J=8, 2$), 7.06-7.22 (6H, m)
3	Compound of Preparation 17	H	Me ^a	101-104	^1H NMR (CDCl_3): δ 1.41 (3H, d, $J=7$), 1.40-1.88 (6H, m), 3.94 (3H, s), 3.96-4.01 (1H, m), 3.99 (2H, q, $J=7$), 5.00-5.07 (1H, m), 6.78 (1H, d, $J=8$), 7.04 (1H, d, $J=8$), 7.10-7.24 (6H, m), 7.34 (1H, s). FABMS (m/e): 398 ($M^+ + 1$)

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Example	Ester	R ⁴	R ³	M.P. °C	Data
4	Compound of Preparation 18	Et	H	138-140 ^b	Anal. Calc'd for C ₂₄ H ₂₉ NO ₅ : C, 70.05; H, 7.10; N, 3.40. Found: C, 70.11; H, 7.21; N, 3.42
5	Compound of Preparation 19	Pr	H	153-155	Anal. Calc'd for C ₂₅ H ₃₁ NO ₅ : C, 70.56; H, 7.34; N, 3.29. Found: C, 70.49; H, 7.39; N, 3.33

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^a trans stereochemistry^b recrystallized from EtOAcEXAMPLE 6(+)-5-Ethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline-5-carboxylic Acid

10 A mixture of 1.03 g (2.5 mmol) of the compound of Example 4 and 303 mg (2.5 mmol) of (R)-(+)- α -methylbenzylamine were dissolved in 50 ml of MeOH and the solvent was removed. The residual oil crystallized on standing in the refrigerator overnight and was triturated in ether. The solid, 1.17 g, was recrystallized four times from EtOAc to give 340 mg of a fluffy white solid, mp 144-145°C; $[\alpha]_D +26.3^\circ$ (MeOH). The salt was partitioned between 20 ml of aqueous 1N HCl solution and 40 ml of EtOAc. The organic layer was washed with additional aqueous 1N HCl solution (2 x 20 ml), dried (MgSO_4), and evaporated to 234 mg of a solid. Recrystallization from hexane-EtOAc provided 192 mg of the title compound, mp 122-124°, $[\alpha]_D +30.7^\circ$ (CHCl_3). Calc'd. for C₂₄H₂₉NO₅: C, 70.05; H, 7.10; N, 3.48. Found: C, 70.12; H, 6.80; N, 3.32.

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EXAMPLE 7(-)-5-Ethyl-3-[4-methoxy-3-(phenylpentyloxy)]phenyl-2-isoxazoline-5-carboxylic Acid

All the mother liquors derived from the (R)- α -methylbenzylamine salt described in Example 6 were combined, concentrated, and partitioned between EtOAc (100 ml) and aqueous 1N HCl solution (50 ml). The organic layer was separated, washed with additional aqueous 1N HCl solution (2 x 50 ml), dried (MgSO_4), and evaporated to 722 mg (1.75 mmol) of a solid. The solid and 212 mg (1.75 mmol) of (S)-(-)- α -methylbenzylamine were dissolved in 30 ml of EtOAc and crystallization was induced by scratching with a glass rod to yield 605 mg of salt. Two recrystallizations from EtOAc gave 483 mg of pure salt, mp 145-146°C; $[\alpha]_D -26.3^\circ$ (MeOH). The salt was neutralized as described in Example 6 to provide 334 mg of the title compound, mp 122-123°C. $[\alpha]_D -31.0^\circ$ (CHCl_3). Calc'd. for C₂₄H₂₉NO₅: C, 70.05; H, 7.10; N, 3.48. Found: C, 70.02; H, 6.85; N, 3.36.

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EXAMPLE 8

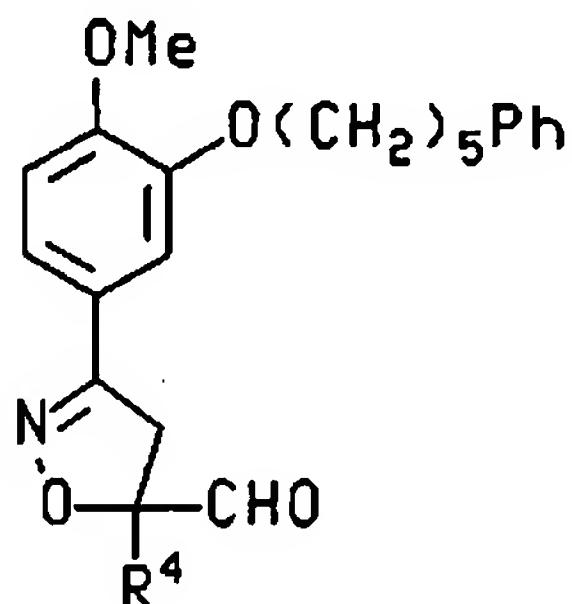
(-)-3-[4-Methoxy-3-(5-phenylpentyloxy)phenyl-5-methyl-2-isoxazoline-5-carboxaldehyde

To a solution of 290 mg (0.579 mmol) of the compound of Preparation 22 in 20 ml of dry THF at about -78°C was added dropwise 1.74 ml (1.74 mmol) of a solution of 5 1M diisobutylaluminum hydride in hexane at such a rate that the reaction temperature was maintained below about -65°C. After about 20 min of stirring the reaction was allowed to warm to RT where TLC analysis indicated the presence of starting material. The mixture was recooled to about -78°C, treated with an additional 0.580 ml of 1M diisobutylaluminum hydride solution, and then allowed to warm to RT. A solution (6 ml) 10 of 1N aqueous HCl was added and the organic layer was extracted with EtOAc (2 x 50 ml). The combined extracts were dried (MgSO_4) and evaporated to 246 mg of a yellow oil. Purification by flash chromatography using a EtOAc-hexane (1:1) eluant gave 137 mg of the title compound as an oil. ^1H NMR (CDCl_3): δ 1.28-1.93 (6H, m), 1.58 (3H, s), 2.63 (2H, t, $J=7$), 3.06 (1H, d, $J=16$), 3.66 (1H, d, $J=16$), 3.90 (3H, s), 4.03 (2H, t, $J=7$), 15 6.83 (1H, d, $J=8$), 7.00 (1H, d, $J=8$), 7.15-7.31 (6H, m) 9.65 (1H, s); MS (m/e): 382 ($M^+ + 1$), 352; $[\alpha]_D -35.1^\circ$ (CHCl_3).

EXAMPLES 9 - 11

The following compounds were prepared substantially according to the procedure of Example 8 substituting the indicated amide for that of Procedure 22.

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Example	Amide	R ⁴	M.P. °C	$[\alpha]_D$ (CHCl_3)	Data
9	Cmpd of Prep. 24	Me	oil	+36.6°	MS (m/e): 382 ($M^+ + 1$), 352

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Example	Amide	R ⁴	M.P. °C	[α] _D (CHCl ₃)	Data
10	Cmpd of Prep. 28	Pr	oil	-29.4°	¹ H NMR (CDCl ₃): δ 0.96 (3H, t), 1.39-1.93 (10H, m), 2.62 (2H, t, J=8), 3.06 (1H, d, J=17), 3.59 (1H, d, J=17), 3.86 (3H, s), 4.00 (3H, t, J=7), 6.83 (1H, d, J=8), 7.07 (1H, dd, J=8, 2), 7.23-7.30 (6H, m), 9.67 (1H, s)
11	Cmpd of Prep. 27	Pr	oil	+37.1°	MS (m/e): 410 (M ⁺ + 1), 382

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EXAMPLE 12

5-Hydroxy-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline

To a solution of 500 mg (1.26 mmol) of the compound of Preparation 29 in 15 ml of MeOH was added 0.50 ml (1.50 mmol) of 3M NaOMe solution in MeOH. After stirring for about 1 hr at RT, the mixture was evaporated and the residue was diluted with 10 ml of ice water. The mixture was acidified with aqueous 6M HCl solution, extracted with EtOAc (2 x 50 ml), washed with brine (50 ml), dried (Na₂SO₄), and evaporated to 307 mg of an oil. Purification by flash chromatography using a EtOAc-hexane (1:1) eluant afforded 307 mg of the title compound, mp 89-91°C. Anal. Calc'd., for C₂₀H₂₅NO₄: C, 70.96; H, 7.09; N, 3.93. Found: C, 70.86; H, 7.10; N, 3.97.

EXAMPLE 13

(+)-5-Hydroxymethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline

To a solution of 300 mg (0.617) of the compound of Preparation 20 in 10 ml of dry THF chilled to about -78°C was added dropwise 1.85 ml (1.85 mmol) of 1M diisobutylaluminum hydride solution in hexane. After stirring for 20 min at about -78°C, the mixture was allowed to warm to about -20°C and was quenched with 4 ml of aqueous 1N HCl solution. The mixture was concentrated, dissolved in 30 ml of EtOAc, washed with water (2 x 30 ml), dried (MgSO₄), and evaporated to 200 mg of a brown oil.

A solution of 184 mg of the oil above in 3 ml of MeOH was treated with 19 mg (0.50 mmol) of sodium borohydride, and the mixture was allowed to stir at RT for about 16 h. The mixture was quenched with aqueous 1N HCl solution and was partially evaporated to remove MeOH. The residue was extracted with EtOAc (1 x 50 ml) and

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the organic layer was separated, washed with water, dried ($MgSO_4$), and evaporated to a brown oil. Purification by flash chromatography (10 g of silica gel) using a EtOAc-hexane (2:3) eluant afford 96 mg of the title compound as an oil. 1H NMR ($CDCl_3$): δ 1.46-1.92 (6H, m), 2.62 (3H, t, $J=8$), 3.18-3.39 (2H, m), 3.63-3.90 (2H, m), 3.86 (3H, s), 5 4.80-4.85 (1H, m), 6.83 (1H, d, $J=8$), 7.02 (1H, dd, $J=8, 2$), 7.12-7.33 (5H, m), MS (m/e): 370 ($M^+ + 1$). $[\alpha]_D +58.0^\circ$ ($CHCl_3$).

EXAMPLE 14

(-)-5-Hydroxymethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline

The title compound was prepared substantially according to the procedure of
10 Example 13 substituting the compound of Preparation 21 for the compound of Preparation 20. $[\alpha]_D -60.0^\circ$ ($CHCl_3$).

EXAMPLE 15

(+)-5-Hydroxymethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-5-methyl-2-isoxazoline

A solution of 200 mg (0.524 mmol) of the compound of Example 9 in 4 ml of
15 MeOH was treated with 18 mg (0.524 mmol) of sodium borohydride and the mixture
was stirred for about 16 h at RT. The mixture was quenched with aqueous 1N HCl
solution and was partially evaporated to remove MeOH. The residue was diluted with
50 ml of water, extracted with EtOAc (2 x 50 ml), dried ($MgSO_4$), and evaporated to 194
mg of an oil. Crystallization of the oil from hexane-ether (3:1) afforded 131 mg of the
20 title compound, mp 76-78°C. $[\alpha]_D +34.7^\circ$ ($CHCl_3$). Anal. Calc'd for $C_{23}H_{29}NO_4 \bullet \frac{1}{4}H_2O$:
C, 71.14; H, 7.60; N, 3.61. Found: C, 71.51; H, 7.72; N, 3.71.

EXAMPLE 16

(-)-5-Hydroxymethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-5-methyl-2-isoxazoline

The title compound was prepared substantially according to the procedure of
25 Example 15 substituting the compound of Example 8 for the compound of Example 9,
mp 86-88°C. $[\alpha]_D -38.2^\circ$ ($CHCl_3$). Anal. Calc'd. for $C_{23}H_{29}NO_4 \bullet \frac{1}{4}H_2O$: C, 71.14; H,
7.60; N, 3.61. Found: C, 71.51; H, 7.72; N, 3.71.

EXAMPLE 17

(+/-)-5-Hydroxymethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-5-methyl-2-isoxazoline

30 To a solution of 200 mg (0.47 mmol) of the compound of Preparation 16 in 5 ml
of THF chilled to about -78°C was added dropwise 1.03 ml (1.03 mmol) of 1.0 M
diisobutylaluminum hydride solution in hexane. The mixture was allowed to warm to
about 0°C where TLC analysis indicated the presence of starting material. After
rechilling to about -78°C, an additional 1.03 ml of a 1.0 M diisobutylaluminum hydride

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solution in hexane was added and the mixture was allowed to warm to about -30°C. The mixture was quenched with aqueous 1N HCl solution and after warming to RT was extracted with EtOAc (2 x 25 ml). The combined organic layers were dried (MgSO_4) and evaporated to 199 mg of a yellow oil. Purification of the oil by flash chromatography (15 g of silica gel) using a EtOAc-hexane eluant (3:2) afforded 163 mg of an oil which spontaneously crystallized upon standing. Trituration with hexane-ether (3:1) afforded 69 mg of the title compound, mp 67-69°C. ^1H NMR (CDCl_3): δ 1.39 (3H, s), 1.41-1.94 (6H, m), 2.61 (2H, t, $J=8$), 2.96 (1H, d, $J=16$), 3.44 (1H, d, $J=16$), 3.49-3.72 (2H, m), 3.85 (3H, s), 4.00 (2H, t, $J=7$), 6.82 (1H, d, $J=9$), 6.99 (1H, dd, $J=2, 9$), 7.14-10 7.32 (6H, m). FABMS (m/e): 384 (M^++1).

EXAMPLE 18

(+)-5-Ethyl-5-hydroxymethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-oxazoline

The title compound was prepared as an oil substantially according to the procedure of Example 13 substituting the compound of Preparation 25 for the compound of Preparation 20. ^1H NMR (CDCl_3): δ 0.98 (3H, t, $J=7$), 1.52-1.93 (8H, m), 2.35-2.70 (1H, bd s), 2.65 (2H, t, $J=7$), 3.06 (1H, d, $J=17$), 3.36 (1H, d, $J=17$), 3.60 (1H, d, $J=12$), 3.75 (1H, d, $J=12$), 3.89 (3H, s), 4.04 (2H, t, $J=7$), 6.85 (1H, d, $J=8$), 7.04 (1H, dd, $J=2, 8$), 7.18-7.35 (6H, m). MS (m/e): 397, 362, 310, 91 (base). $[\alpha]_D +20.1^\circ$ (CHCl_3).

20

EXAMPLE 19

(-)-5-Ethyl-5-hydroxymethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-oxazoline

The title compound was prepared as an oil substantially according to the procedure of Example 13 substituting the compound of Preparation 26 for the compound of Preparation 20. $[\alpha]_D -16.3^\circ$ (CHCl_3).

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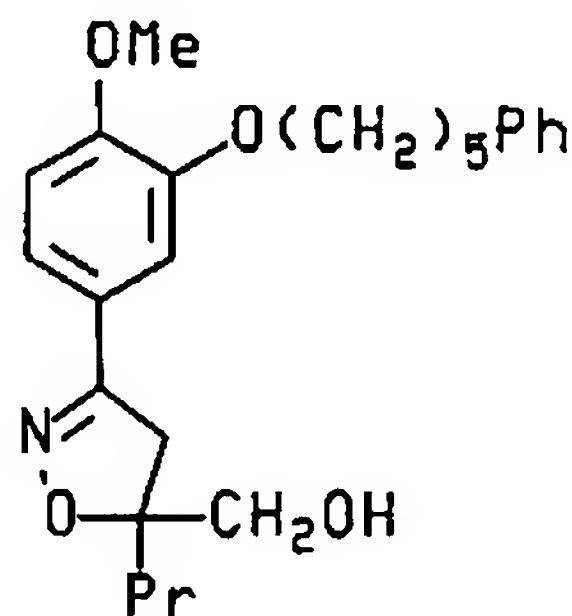
EXAMPLES 20 - 21

The following compounds were prepared as oils substantially according to the procedure of Example 15 substituting the indicated aldehyde for the compound of Example 9.

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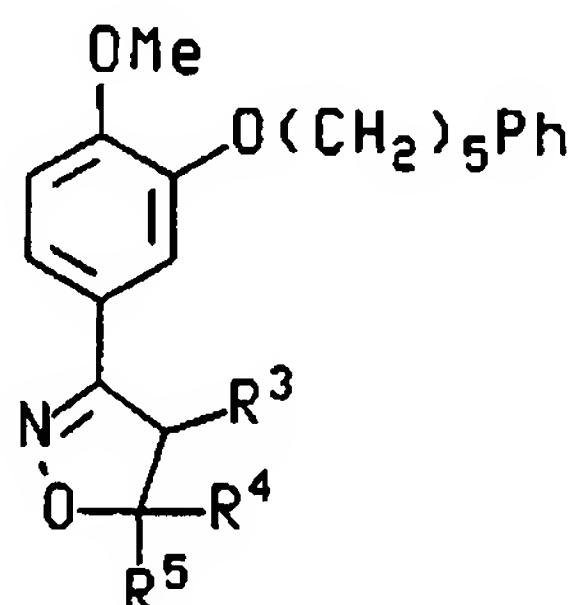
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Ex.	Aldehyde	$[\alpha]_D$ (CHCl_3)	$^1\text{H NMR}$ (CDCl_3):
20	Cmpd of Ex. 11	+8.9°	δ 0.93 (3H, t, J=7), 1.36-1.90 (10H, m), 2.62 (2H, t, J=8), 3.03 (1H, d, J=17), 3.34 (1H, d, J=17), 3.52-3.74 (2H, m), 3.86 (3H, s), 4.01 (2H, t, J=7), 6.82 (1H, d, J=8), 7.01 (1H, dd, J=2, 8), 7.15-7.32 (6H, m)
21	Cmpd of Ex 10	-9.8°	MS (m/e): 412 ($M^+ + 1$), 382, 312

EXAMPLES 22 - 28

The following compounds were prepared substantially according to the procedure of Preparation 15 substituting the indicated olefin for ethyl acrylate.

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Ex	R ⁵	R ⁴	R ³	Olefin	M.P. °C	Data
5	22	H	H	CH ₂ =CH ₂	103-105	Anal. Calc'd. for C ₂₁ H ₂₅ NO ₃ •1/4H ₂ O; C, 73.33; H, 7.32; N, 4.07. Found: C, 73.56; H, 7.20; N, 4.13
	23	Me	Me	Me ₂ C=CH ₂	83-85	Anal. Calc'd. for C ₂₃ H ₂₉ NO ₃ •1/4H ₂ O; C, 74.26; H, 7.85; N, 3.36. Found: C, 74.56; H, 7.90; N, 3.84
	24	COCH ₃	H	CH ₂ =CHCOCH ₃	oil	¹ H NMR (CDCl ₃): δ 1.46-1.90 (6H, m), 2.35 (3H, s), 2.62 (2H, t, J=8), 3.39-3.62 (2H, m), 3.86 (3H, s), 4.01 (2H, t, J=7), 4.97 (1H, dd, J=6, 11), 6.83 (1H, d, J=8), 7.03 (1H, dd, J=2, 8), 7.15-7.33 (6H, m)
10	25	CONH ₂	H	CH ₂ =CHCONH ₂	152-154	Anal. Calc'd for C ₂₂ H ₂₆ N ₂ O ₄ : C, 69.08; H, 6.85; N, 7.32. Found: C, 68.80; H, 6.64; N, 7.26
	26	(CH ₂) ₂ OH	H	CH ₂ =CH(CH ₂) ₂ -OH	84-86	¹ H NMR (CDCl ₃): δ 1.40-1.81 (8H, m), 2.59 (2H, t, J=7), 3.05 (1H, dd, J=8, 17), 3.43 (1H, dd, J=10, 17), 3.52 (2H, q, J=5), 3.77 (3H, s), 3.96 (2H, t, J=6), 4.56 (1H, t, J=5), 4.70-4.75 (1H, m), 6.98 (1H, d, J=8), 7.12-7.29 (7H, m), MS (m/e): 384 (M ⁺ +1)

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Ex	R ⁵	R ⁴	R ³	Olefin	M.P. °C	Data
27	H	-CH ₂ OCH ₂ OCH ₂ - ^a			122-125	¹ H NMR (CDCl ₃): δ 1.48-1.89 (6H, m), 2.62 (2H, t, J=8), 3.86 (3H, s), 3.91-4.40 (8H, m), 4.69 (1H, d, J=6), 4.87 (1H, d, J=6), 6.86 (1H, d, J=8), 7.03 (1H, dd, J=2, 8), 7.17-7.32 (6H, m), MS (m/e): 412 (M ⁺ +1)
28	CH ₂ NH-CO ₂ F ₃	H	H	Preparation 14	91-94	¹ H NMR (CDCl ₃): δ 1.39-1.94 (6H, m), 2.56 (2H, t, J=7), 2.95 (1H, dd, J=8, 16) 3.17 (1H, dd, J=12, 16), 3.17-3.48 (1H, m), 3.60-3.68 (1H, m), 3.91 (3H, s), 3.95 (2H, t, J=7), 4.72-4.82 (1H, m), 6.64 (1H, bd s), 6.75 (1H, d, J=8), 6.92 (1H, dd, J=2, 8) 7.07-7.22 (6H, m). FABMS (m/e): 465 (M ⁺ +1)

5 ^a cis stereochemistry in the ring juncture

EXAMPLE 29

5-Aminomethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline Hydrochloride

10 A mixture of 250 mg (0.538 mmol) of the compound of Example 28, 5 ml of MeOH, and 1 ml of water was treated with 91 mg (1.62 mmol) of KOH and was allowed to stir for about 16 h at RT. The mixture was partially evaporated to remove MeOH and the residue was diluted with EtOAc (50 ml) and sat'd. aqueous NaHCO₃ solution (50 ml). The organic layer was separated and washed with an additional 50 ml of sat'd. aqueous NaHCO₃ solution, dried (MgSO₄), and evaporated to an oil. NMR analysis indicated the presence of a small amount of starting material, so the oil was treated again as described above using 30 mg of KOH. After work-up 126 mg of an oil was obtained, which was treated with HCl gas in 3 ml of CHCl₃. The solvent was

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evaporated and the semi-solid residue was triturated in ether to yield 70 mg of the title compound, mp 106-109°C. Anal. Calc'd for $C_{22}H_{28}N_2O_3 \bullet HCl$: C, 63.78; H, 7.00; N, 6.76. Found: C, 63.93; H, 7.29; N, 6.65.

EXAMPLE 30

5 5-Amino-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline-5-carboxylic Acid Hydrobromide

A mixture of 50 mg (0.094 mmol) of the compound of Preparation 30 and 2 ml of bromotrimethylsilane was stirred for about 16 hr at RT. A precipitate was observed and a small amount of acetonitrile was added and the mixture was heated to reflux.

10 The mixture was evaporated and the residue was triturated with ether to afford 57 mg of the title compound, mp 123-127°C. 1H NMR (CD_3OD): δ 1.47-1.88 (6H, m), 2.64 (2H, t, J=7), 3.82 (1H, d, J=17), 3.88 (3H, s), 4.02 (2H, t, J=8), 4.29 (1H, d, J=17), 7.03 (1H, d, J=8), 7.12-7.33 (7H, m). FABMS (m/e): 477, 399.

EXAMPLES 31 - 32

15 Racemic Diastereomers of 5-(1-Hydroxyethyl)-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline

To a solution of 360 mg (0.944 mmol) of the compound of Example 24 in 4 ml of MeOH chilled to about 0°C was added 36.0 mg (0.944 mmol) of $NaBH_4$. After the bubbling ceased, the ice bath was removed and stirring was continued for about 1 h.

20 Excess aqueous 1N HCl solution was added and the mixture was partially evaporated to remove MeOH. The residue was diluted with 50 ml of water and extracted with EtOAc (2 x 50 ml). The combined EtOAc extracts were dried ($MgSO_4$) and evaporated to 360 mg of an oil, which was separated by flash chromatography (50 g of silica gel) using ether-hexane (7:3) and ether as eluants. The fractions containing the less polar

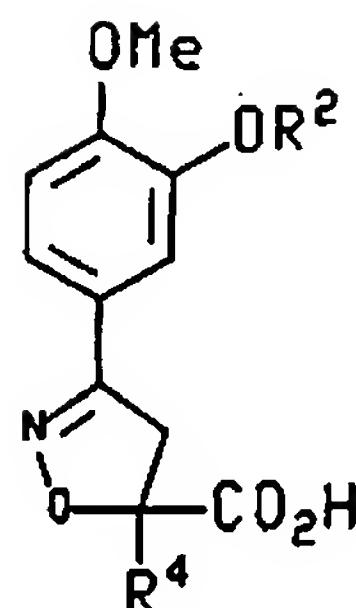
25 diastereomer (R_f 0.28, ether) were combined and evaporated to 31 mg of an oil which was crystallized from hexane, mp 102-103°C. Anal. Calc'd for $C_{23}H_{29}NO_4$: C, 72.04; H, 7.62; N, 3.65. Found: C, 72.22; H, 7.57; N, 3.41.

The fractions containing the more polar diastereomer (R_f 0.23, ether) were combined and evaporated to 117 mg of an oil which was crystallized from hexane, mp 30 72-74°C. Anal. Calc'd for $C_{23}H_{29}NO_4$: C, 72.04; H, 7.62; N, 3.65. Found: C, 72.26; H, 7.57; N, 3.50.

EXAMPLES 33 - 36

The following compounds were prepared by saponification of the indicated ester, substantially according to the procedure of Example 1.

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Ex.	R ²	R ⁴	Ester	M.P. °C	Data
33	cyclopentyl	H	Cmpd. of Prep. 31	135-137	Anal. Calc'd for C ₁₆ H ₁₉ NO ₆ : C, 62.94; H, 6.27; N, 4.59. Found: C, 62.82; H, 6.01; N, 4.59.
34	cyclopentyl	Me	Cmpd. of Prep. 32	149-151	Anal. Calc'd for C ₁₇ H ₂₁ NO ₅ • _{1/4} H ₂ O: C, 62.99; H, 6.64; N, 4.32. Found: C, 63.22; H, 6.38; N, 4.32.
35	(CH ₂) ₄ Ph	H	Cmpd. of Prep. 35	108-110	¹ H NMR (DMSO-d ₆): δ 1.60-1.75 (4H, m), 2.64 (2H, t, J=6), 3.50-3.72 (2H, m), 3.78 (3H, s), 3.99 (2H, t, J=6), 5.11 (1H, dd, J=3, 11), 6.99 (1H, d, J=8), 7.16-7.30 (7H, m).
36		H	Cmpd. of Prep. 33	oil	¹ H NMR (CDCl ₃): δ 1.10-1.82 (8H, m), 2.28 (1H, s), 2.49 (1H, d, J=2), 3.65-3.70 (2H, m), 3.85 (3H, s), 4.20 (1H, d, J=4), 5.18 (1H, dd, J=5, 12), 6.82 (1H, d, J=8), 7.01 (1H, d, J=8), 7.27 (1H, s).

EXAMPLE 373-(3-Cyclopentyloxy-4-methoxy)phenyl-2-isoxazoline-5-carboxaldehyde

25 To a solution of 250 mg (0.750 mmol) of the compound of Preparation 31 in 5 ml of THF chilled to about -78°C was added dropwise 1.88 ml (1.88 mmol) of a 1M diisobutylaluminum hydride solution in hexane. The mixture was stirred for about 30 min at about -78°C and was quenched by the addition of 3 ml of MeOH. Following the

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addition of 10 ml of 1N aqueous HCl solution, the mixture was allowed to warm to RT and was partially evaporated to remove THF and MeOH. The residue was extracted with EtOAc (2 x 50 ml) and the combined extracts were washed with sat'd. aqueous NaHCO₃ (2 x 30 ml), dried (Na₂SO₄), and evaporated to 205 mg of an oil. Purification 5 of the oil by flash chromatography (50 g of silica gel) using an EtOAc-hexane (1:1 to 3:1) eluant afforded 173 mg of the title compound as an oil. The NMR spectrum indicated partial hydration of the aldehyde. ¹H NMR (CDCl₃): δ 1.50-2.05 (8H, m), 3.20-3.62 (2.5H, m), 3.83 and 3.84 (3H, two s), 4.66-4.85 (1.5 H, m), 4.98-5.07 (1H, m), 6.84 (1H, d, J=8), 7.04 (1H, dd, J=2, 8), 7.35 (1H, d, J=2), 9.80 (0.5 H, s).

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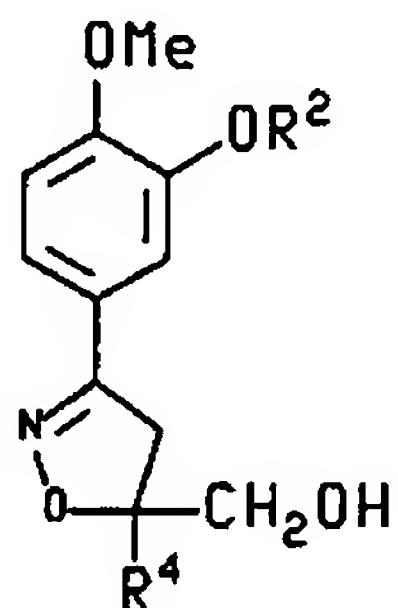
EXAMPLE 38

3-[3-(S)-(exo)-Bicyclo[2.2.1]hept-2-yloxy-4-methoxy]phenyl-5-methyl-2-isoxazoline-5-carboxaldehyde

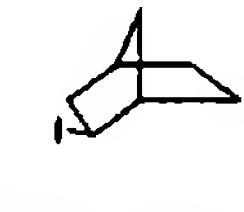
The title compound was prepared as an oil by diisobutylaluminum hydride reduction of the compound of Preparation 34, substantially according to the procedure 15 of Example 8. ¹H NMR (CDCl₃): δ 1.10-1.82 (8H, m), 1.56 (3H, s), 2.25-2.50 (1H, m), 2.49 (1H, d, J=1), 3.06 (1H, d, J=17), 3.65 (1H, d, J=17), 3.84 (3H, s), 4.11 (1H, d, J=6), 6.81 (1H, d, J=8), 6.98 (1H, dd, J=2, 8), 7.27 (1H, d, J=2), 9.67 (1H, s). MS (m/e): 330 (M⁺+1). [α]_D -24.3° (CHCl₃).

EXAMPLES 39 and 40

20 The following compounds were prepared as oils by NaBH₄ reduction of the indicated aldehydes, substantially according to the procedure of Example 15.



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Ex	R ²	R ⁴	Aldehyde	[α] _D (CHCl ₃)	Data
39	cyclopentyl	H	Cmpd. of Example 37	-	¹ H NMR (CDCl ₃): δ 1.50-2.05 (8H, m), 3.15-3.36 (2H, m), 3.60-3.85 (2H, m), 3.94 (3H, s), 3.73-3.85 (2H, m), 6.79 (1H, d, J=8), 6.98 (1H, dd, J=2, 8), 7.30 (1H, d, J=2). FABMS (m/e): 292 (M ⁺ + 1)
5	40	Me	Cmpd. of Example 38  (S)-(+)-exo	-4.8°	¹ H NMR (CDCl ₃): δ 1.10-1.82 (m, 8H), 1.39 (3H, s), 1.97 (1H, dd, J=5, 6), 2.24-2.28 (1H, m), 2.49 (1H, d, J=4), 2.97 (1H, d, J=17), 3.43 (1H, d, J=17), 3.52-3.73 (2H, m), 3.84 (3H, s), 4.21 (1H, d, J=7), 6.81 (1H, d, J=8), 7.10 (1H, dd, J=2, 8), 7.28 (1H, d, J=2). FABMS (m/e): 332 (M ⁺ + 1)

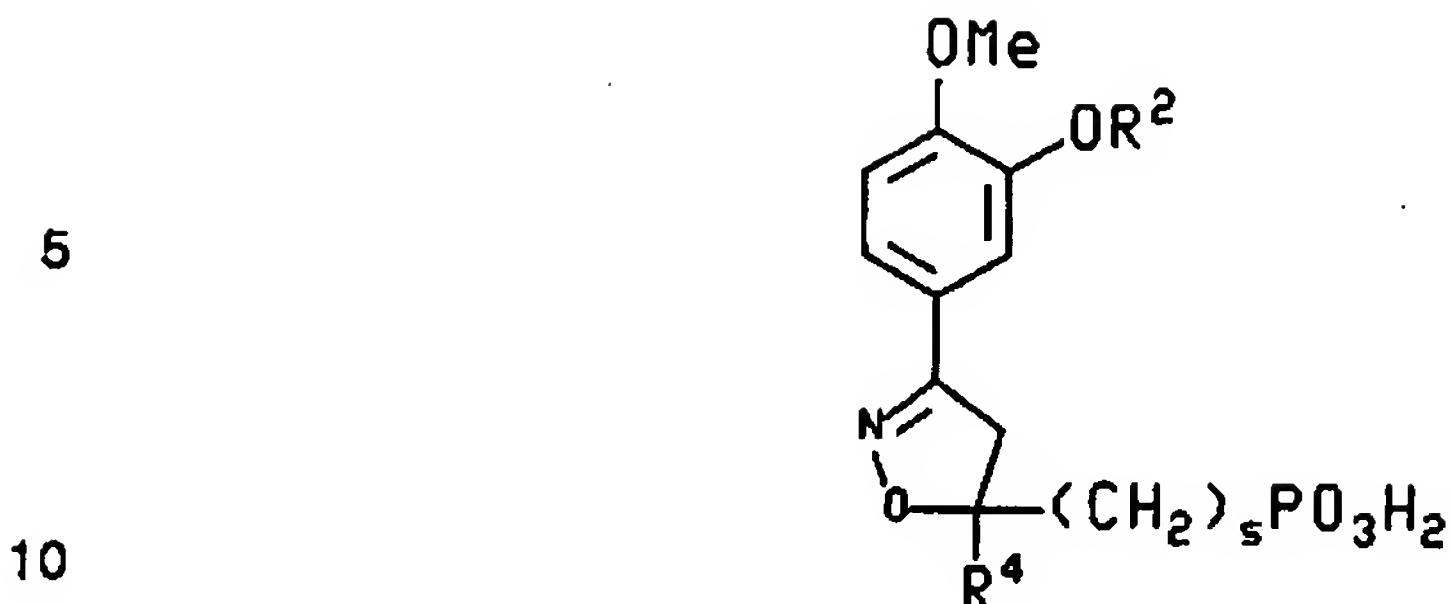
EXAMPLE 413-[4-Methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazolin-5-ylphosphonic Acid

A solution of 50 mg of the compound of Preparation 38 in 1 ml of trimethylsilyl-bromide was stirred for about 2 h at RT. The mixture was evaporated and the residue was diluted with water (4 ml) and CH₂Cl₂ (3 ml) and was stirred for about 2 h. The mixture was filtered and the aqueous layer was basified with aqueous 1N NaOH solution. The organic layer was separated and the aqueous layer was washed with additional CH₂Cl₂ (2 x 15 ml). Acidification of the aqueous layer with aqueous 1N HCl solution, extraction with EtOAc (2 x 15 ml), drying (MgSO₄), and evaporation afforded 42 mg of the title compound as an oil. ¹H NMR (DMSO-d₆): δ 1.37-1.78 (6H, m), 2.58 (2H, t, J=7), 3.57-3.77 (2H, m), 3.89 (3H, s), 3.96 (2H, t, J=7), 4.61 (1H, t, J=10), 7.97 (1H, d, J=8), 7.08-7.26 (7H, m), FABMS (m/e): 420 (M⁺ + 1).

EXAMPLES 42 - 45

20 The following compounds were prepared in an analogous manner to the procedure of Example 41 using as starting material the compounds from the indicated Preparations.

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	Ex	R ²	R ⁴	s	Cmpd of Prep	M.P.°C	Data
15	42	(CH ₂) ₅ Ph	Me	0	39	175-177 ^a	Calc'd. for C ₂₂ H ₂₈ NO ₆ P•H ₂ O: C, 58.53; H, 6.65; N, 3.10. Found: C, 58.27; H, 6.61; N, 3.16
	43	(CH ₂) ₅ Ph	H	1	40	137-139	Calc'd. for C ₂₂ H ₂₈ NO ₆ P•1/4H ₂ O: C, 60.28; H, 6.51; N, 3.20. Found: C, 60.17; H, 6.32; N, 3.19
	44	(CH ₂) ₅ Ph	Me	1	41	112-115 ^a	Calc'd. for C ₂₃ H ₃₀ NO ₆ P•H ₂ O: C, 59.29; H, 6.87; N, 3.00. Found: C, 58.99; H, 6.94; N, 2.97
20	45	cyclopentyl	H	0	42	166-168	¹ H NMR (DMSO-d ₆): δ 1.50-1.90 (8H, m), 3.22-3.70 (2H, m), 3.73 (3H, s), 4.56 (1H, t, J=12), 4.72-4.80 (1H, m), 6.93 (1H, d, J=8), 7.09 (1H, d, J=8), 7.16 (1H, s)

^a recrystallized from EtOAc

PREPARATION 1

25 4-Methoxy-3-(5-phenylpentyloxy)benzaldehyde Oxime

A mixture of 25.0 g (0.164 mol) of isovanillin, 26.9 g (0.164 mol) of 5-phenyl-1-pentanol, 64.5 g (0.246 mol) of triphenylphosphine and 250 ml of THF was treated dropwise with 42.8 g (0.246 mol) of diethyl azodicarboxylate. The mixture was heated to about 90°C for about 6 h and then stirred overnight at RT. The solvent was evaporated and the residue was diluted with 500 ml of EtOAc, washed with water (1 x 400 ml), 1N NaOH solution (2 x 400 ml), brine (1 x 400 ml), dried (MgSO₄), and evaporated to 119 g of a brown oil. Purification by flash chromatography (750 g of silica gel) using an EtOAc-hexane (3:7) eluant afforded 29.8 g (61%) of the title compound as an oil. ¹H NMR (CDCl₃): δ 1.42-1.92 (6H, m), 2.61 (2H, t, J=7), 3.91 (3H,

-27-

s), 4.03 (2H, t, J=7), 6.91 (1H, d, J=8), 7.10–7.40 (m, 7H), 9.77 (s, 1H).

To a solution of 29.8 g (0.100 mol) of the aldehyde above in 300 ml of 95% ethanol was added 13.7 g (0.197 mol) of hydroxylamine hydrochloride in 100 ml of water followed by 16.6 g (0.197 mol) of sodium bicarbonate in small portions (gas evolution!). The mixture was stirred for about 4 h at RT and the ethanol was removed by evaporation. The residue was diluted with 250 ml of water and extracted with EtOAc (2 x 200 ml). The combined extracts were dried (MgSO_4) and evaporated to a yellow oil which was crystallized from hexane/ether to afford 15.0 g of the title compound, mp 65-67°C. ^1H NMR (CDCl_3): δ 1.46–1.93 (6H, m), 2.62 (2H, t, J=7), 3.88 (3H, s), 4.02 (2H, t, J=7), 6.99–7.62 (m, 6H), 7.49 (1H, s), 8.04 (1H, s).

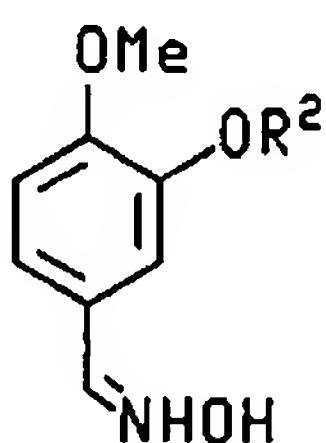
An additional 2.00 g of product was obtained as a second crop from the filtrate, mp 67-69°C. Evaporation of the filtrate and purification of the residue by flash chromatography using an EtOAc-hexane (2:3) eluant also provided an additional 4.18 g of product, mp 64-66°C.

15

PREPARATIONS 2 – 4

Reaction of the appropriate alcohol with isovanillin and condensation of the resulting aldehyde with hydroxylamine hydrochloride, substantially according to the procedure of Preparation 1, afforded the following compounds as oils.

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Prep. #	R ²	^1H NMR CDCl_3 , δ
2	(CH ₂) ₄ Ph	1.70–1.90 (m, 4H), 2.65 (2H, t, J=7), 3.95 (3H, s), 4.10 (2H, t, J=7), 6.90 (1H, d, J=8), 6.94–7.26 (6H, m), 6.97 (1H, dd, J=2, 8), 7.56 (1H, s), 8.01 (1H, s)
3	cyclopentyl	1.50–2.02 (8H, m), 3.94 (3H, s), 4.62–4.80 (1H, m), 6.91 (1H, d, J=8), 6.97 (1H, dd, J=8 and 1), 7.17 (1H, d, J=1), 8.02 (1H, s), 8.16 (1H, s)

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Prep. #	R ²	¹ H NMR CDCl ₃ , δ
4		1.10-1.80 (8H, m), 2.26-2.32 (1H, m), 2.47-2.52 (1H, m), 3.84 (3H, s), 4.21 (1H, d, J=7), 6.82 (1H, d, J=8), 6.98 (1H, dd, J=8 and 2), 7.13 (1H, d, J=2), 7.78 (1H, s), 8.03 (1H, s)

PREPARATION 5

5

Ethyl 2-Methylenebutyrate

A mixture of 5.0 g (0.019 mol) of triethyl 2-phosphonobutyrate, 5.5 g (0.039 mol) of K₂CO₃, 6.2 g (0.076 mol) of 37% aqueous formaldehyde solution, and 15 ml of water was heated to about 80°C for about 45 min. After cooling to RT, 75 ml of ether was added and the organic layer was separated, washed with brine (1 x 20 ml), dried (MgSO₄), and filtered. The ether was carefully removed by distillation, leaving behind 2.1 g (87%) of the title compound as a clear oil which was used directly without further purification. ¹H NMR (CDCl₃): δ 1.01 (3H, t, J=7), 1.24 (3H, t, J=7), 2.26 (2H, q, J=7), 4.14 (2H, q, J=7), 5.45 (1H, s), 6.06 (1H, s).

PREPARATION 6

15

Ethyl 2-Methylenepentanoate

Reaction of triethyl 2-phosphonopentanoate, substantially according to the procedure of Preparation 5, gave the title compound as an oil. ¹H NMR (CDCl₃): δ 1.05 (3H, t, J=7), 1.28 (3H, t, J=7), 1.41-1.53 (2H, m), 2.87 (2H, q, J=7), 4.18 (2H, q, J=7), 5.49 (1H, s), 6.11 (1H, s).

20

PREPARATION 7

2-Methylenebutyric Acid

To a solution of 5.08 g (39.6 mmol) of the compound of Preparation 5 in 95 ml of EtOH and 40 ml of water was added 1.58 g (39.6 mmol) of solid NaOH, and the mixture was stirred for about 2 h at RT. An additional 0.15 g of NaOH was added and stirring was continued for about 2 h. The mixture was partially evaporated to remove the EtOH and the residue was diluted with 20 ml of H₂O and acidified to pH 2 with aqueous 6N HCl solution. Extraction with EtOAc, drying (MgSO₄), and evaporation afforded 2.49 g (63%) of the title compound as an oil. ¹H NMR (CDCl₃): δ 1.11 (3H, t,

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J=7), 2.34 (2H, q, J=7), 5.66 (1H, s), 6.30 (1H, s), 11.78 (1H, bd s).

PREPARATION 8

2-Methylenepentanoic Acid

Reaction of the compound of Preparation 6, substantially according to the procedure of Preparation 7, gave the title compound as an oil. ^1H NMR (CDCl_3): δ 0.91 (3H, t, J=7), 2.40–2.54 (2H, m), 2.26 (2H, t, J=7), 5.62 (1H, s), 6.27 (1H, s).

PREPARATION 9

(S)-(-)-(N- α -Methylbenzyl)acrylamide

To a solution of 5.0 g (0.055 mol) of acryloyl chloride in 30 ml of CH_2Cl_2 chilled to about 0°C was added dropwise 7.1 ml (6.7 g, 0.055 mol) of (S)-(-)- α -methylbenzylamine. After the exotherm had subsided, 8.5 ml (6.2 g, 0.061 mol) of triethylamine was added dropwise and the mixture was allowed to warm to RT. Following about 2 h of additional stirring, the solvent was removed by evaporation and the residue was taken up in 200 ml of EtOAc and washed with aqueous 1N HCl solution, aqueous sat'd. NaHCO_3 solution, dried (MgSO_4), and evaporated to a solid. Trituration in hexane-ether afforded 7.8 g of the title compound as a solid, mp 97-99°C. ^1H NMR (CDCl_3): δ 1.50 (3H, d, J=7), 5.11–5.21 (1H, m), 5.63 (1H, dd, J=2, 10), 5.77 (1H, bd s), 6.06 (1H, dd, J=10, 13), 6.26 (1H, dd, J=1, 17), 7.19–7.32 (5H, m).

PREPARATION 10

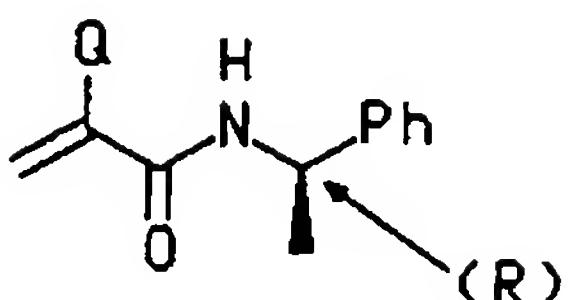
(S)-(-)-(N- α -Methylbenzyl)-2-methylpropionamide

To a solution of 5.00 g (0.0581 mol) of methacrylic acid in 100 ml of THF was added 7.03 g (0.0581 mol) of (S)-(-)- α -methylbenzylamine, 7.84 g (0.0581 mol) of hydroxybenztriazole, and 11.1 g (0.0581 mol) of 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride. After stirring for about 4 h at RT, the solvent was removed by evaporation and the residue was taken up in 200 ml of EtOAc and washed with water (2 x 100 ml), aqueous 1N HCl solution (2 x 100 ml), sat'd. aqueous NaHCO_3 solution, dried (MgSO_4), and evaporated to solid. Trituration in hexane-ether (2:1) afforded 8.68 g of the title compound as a white solid, mp 95-98°C. ^1H NMR (CDCl_3): δ 1.51 (3H, d, J=7), 1.93 (3H, s), 5.09–5.19 (1H, m), 5.29 (1H, s), 5.65 (1H, s), 5.95 (1H, bd s), 7.20–7.34 (5H, m).

PREPARATIONS 11 – 13

Reaction of the appropriate acid with (R)-(+)- α -methylbenzylamine, substantially according to the procedure of Preparation 10, afforded the following compounds.

-30-



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Prep. #	Q	Acid	M.P. °C	^1H NMR CDCl_3, δ
10	11	Me Methacrylic acid	93-95	1.53 (3H, d, J=7), 1.97 (3H, s), 5.10-5.23 (1H, m), 5.23 (1H, s), 5.64 (1H, s), 6.01 (1H, bd s), 7.25-7.37 (5H, m)
	12	Et Cmpd of Prep 7	oil	1.07 (3H, t, J=7), 1.53 (3H, d, J=7), 2.34 (2H, q, J=7), 5.13-5.25 (1H, m), 5.26 (1H, s), 5.59 (1H, s), 6.06 (1H, bd s), 7.20-7.35 (5H, m)
	13	Pr Cmpd of Prep 8	69-71	0.91 (3H, t, J=7), 1.29-1.54 (2H, m), 1.53 (3H, d, J=8), 2.28 (2H, t, J=8), 5.12-5.22 (1H, m), 5.24 (1H, s), 5.57 (1H, s), 5.95 (1H, bd s), 7.25-7.36 (5H, m)

PREPARATION 14

15

(N-Trifluoroacetyl)allylamine

A solution of 9.97 g (0.175 mol) of allylamine in 100 ml of pyridine chilled to about 0°C was treated dropwise with 37.2 g (0.175 mol) of trifluoroacetic anhydride. After about 2 h of stirring the solvent was removed by evaporation. The residue was taken up in 200 ml of CH_2Cl_2 and washed with aqueous 1N HCl solution (2 x 100 ml), sat'd. aqueous NaHCO_3 solution, dried (Na_2SO_4), and evaporated to give 18.9 g (79%) of the title compound as an oil. ^1H NMR (CDCl_3): δ 3.97 (2H, t, J=5), 5.20 (1H, s), 5.27 (1H, d, J=10), 5.74-5.88 (1H, m), 6.57 (1H, bd s).

PREPARATION 15

3-[4-Methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline-5-carboxylic Acid Ethyl Ester

To a mixture of 1.28 g (9.57 mmol) of N-chlorosuccinimide, 200 μl of pyridine, and 200 ml of CH_2Cl_2 was added 2.00 g (6.38 mmol) of the compound of Preparation

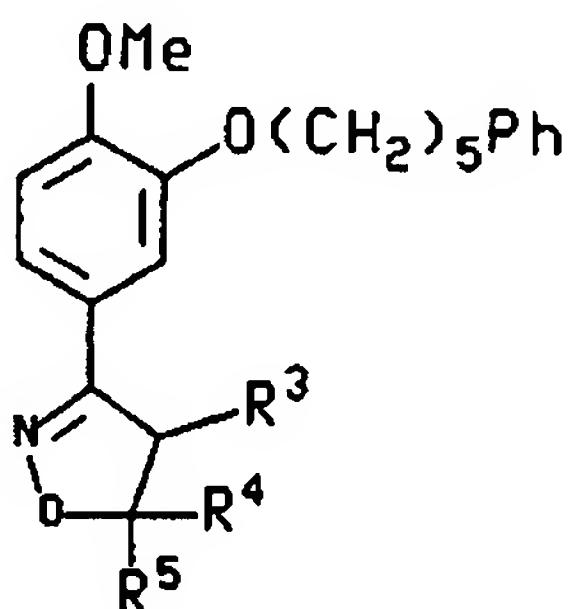
-31-

1 in a solution of 15 ml of CH_2Cl_2 . An exotherm was observed after about 10 min and following about 2 h of stirring at RT, 644 mg (698 μl , 6.38 mmol) of ethyl acrylate was added followed by 966 mg (1.33 ml, 9.57 mmol) of triethylamine. After the exotherm subsided, the mixture was stirred for about 2 h at RT. The mixture was diluted with 250 ml of CH_2Cl_2 and washed with aqueous 1N HCl solution, sat'd. aqueous NaHCO_3 solution, dried (Na_2SO_4), and evaporated to an oil. Purification by flash chromatography (100 g of a silica gel) using an EtOAc-hexane (2:3) eluant afforded 1.82 g (69%) of the title compound as an oil. ^1H NMR (CDCl_3): δ 1.29 (3H, t, $J=7$), 1.40–1.91 (6H, m), 2.60 (2H, t, $J=7$), 3.55–3.58 (2H, m), 3.95 (3H, s), 3.99 (2H, t, $J=7$), 4.22 (2H, q, $J=7$), 5.05–5.12 (1H, m), 6.79 (1H, d, $J=8$), 6.95–7.31 (7H, m).

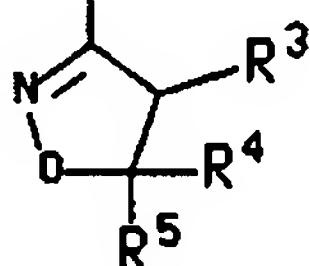
PREPARATIONS 16 – 30

The following compounds were prepared substantially according to the procedure in Preparation 15 substituting the indicated olefin for ethyl acrylate.

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Prep #	R^5	R^4	R^3	Olefin	M.P. °C	Data	
30	16	CO_2Et	Me	H	Ethyl α -meth- acrylate	oil	^1H NMR (CDCl_3): δ 1.25 (3H, t, $J=7$), 1.37–1.90 (6H, m), 1.64 (3H, s), 2.54 (2H, t, $J=7$), 3.11 (1H, d, $J=15$), 3.77 (1H, d, $J=15$), 3.83 (3H, s), 3.95 (2H, q, $J=7$), 4.17 (2H, q, $J=7$), 6.75 (1H, d, $J=8$), 6.90–8.28 (7H, m)
	17	CO_2Et	H	Me ^a	Ethyl crotonate	oil	MS (m/e): 425 (M^+), 279, 91 (base)

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Prep #	R ⁵	R ⁴	R ³	Olefin	M.P. °C	Data
5	18	CO ₂ Et	Et	H	Cmpd of Prep 5	oil MS (m/e): 439 (M ⁺), 310, 105
	19	CO ₂ Et	Pr	H	Cmpd of Prep 6	oil FABMS (m/e): 454 (M ⁺), 380, 310
	20	(S)-CONHCH-(Me)Ph ^b	H	H	Cmpd of Prep 9	85-90 Anal. Calc'd for C ₃₀ H ₃₄ N ₂ O ₄ : C, 74.05; H, 7.04; N, 5.76. Found: C, 74.16; H, 6.93; N, 5.88.
	21	(S)-CONHCH-(Me)Ph ^c	H	H	Cmpd of Prep 9	91-101 Anal. Calc'd for C ₃₀ H ₃₄ N ₂ O ₄ : C, 74.05; H, 7.04; N, 5.76. Found: C, 74.32; H, 6.94; N, 5.71.
	22	(S)-CONHCH-(Me)Ph ^d	Me	H	Cmpd of Prep 10	113-116 Anal. Calc'd for C ₃₁ H ₃₆ N ₂ O ₄ : C, 74.37; H, 7.25; N, 5.60. Found: C, 74.17; H, 6.87; N, 5.53
	23	(R)-CONHCH-(Me)Ph ^e	Me	H	Cmpd of Prep 11	97-99 Anal. Calc'd for C ₃₁ H ₃₆ N ₂ O ₄ •1/4 H ₂ O: C, 73.64; H, 7.23; N, 5.55. Found: C, 73.83; H, 7.35; N, 5.60
	24	(R)-CONHCH-(Me)Ph ^f	Me	H	Cmpd of Prep 11	111-113 Anal. Calc'd for C ₃₁ H ₃₆ N ₂ O ₄ : C, 74.37; H, 7.25; N, 5.60. Found: C, 74.51; H, 7.22; N, 5.43
	25	(R)-CONHCH-(Me)Ph ^g	Et	H	Cmpd of Prep 12	126-130 ¹ H NMR (CDCl ₃): δ 1.06 (3H, t, J=7), 1.53 (3H, d, J=7), 1.53-2.21 (8H, m), 2.65 (2H, t, J=7), 3.23 (1H, d, J=17), 3.67 (1H, d, J=17), 3.89 (3H, s), 4.02 (2H, t, J=7), 5.02-5.15 (1H, m), 6.85 (1H, d, J=8), 7.02 (1H, dd, J=2, 8), 7.16-7.32 (12H, m)

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Prep #	R ⁵	R ⁴	R ³	Olefin	M.P. °C	Data	
26	(R)-CONHCH-(Me)Ph ^a	Et	H	Cmpd of Prep 12	121-123	¹ H NMR (CDCl ₃): δ 0.92 (3H, t, J=7), 1.47 (3H, d, J=7), 1.47-2.18 (8H, m), 2.66 (2H, t, J=7), 3.26 (1H, d, J=17), 3.76 (1H, d, J=17), 3.90 (3H, s), 4.04 (2H, t, J=7), 5.02-5.13 (1H, m), 6.87 (1H, d, J=8), 7.07 (1H, dd, J=2, 8), 7.18-7.36 (12H, m)	
27	(R)-CONHCH-(Me)Ph ^b	Pr	H	Cmpd of Prep 13	123-125	Anal. Calc'd for C ₃₃ H ₄₀ N ₂ O ₄ •1/4 H ₂ O: C, 74.27; H, 7.60; N, 5.25. Found: C, 74.44; H, 7.50; N, 5.21	
28	(R)-CONHCH-(Me)Ph ^c	Pr	H	Cmpd of Prep 13	118-120	Anal. Calc'd for C ₃₃ H ₄₀ N ₂ O ₄ •1/4 H ₂ O: C, 74.27; H, 7.60; N, 5.25. Found: C, 74.08; H, 7.85; N, 5.19	
29	OAc	H	H	Vinyl acetate	oil	¹ H NMR (CDCl ₃): δ 1.46-1.95 (6H, m), 2.17 (3H, s), 2.62 (2H, t, J=8), 3.30 (1H, d, J=18), 3.54-3.60 (1H, m), 3.87 (3H, s), 4.02 (2H, t, J=7), 5.27 (1H, d, J=1), 6.82-7.30 (8H, m)	
5	30	CO ₂ Me	NHCO ₂ Bn	H	H ₂ C=CH(NHCO ₂ Bn)CO ₂ Me	oil	¹ H NMR (CDCl ₃): δ 1.35-1.84 (6H, m), 2.55 (2H, t, J=7), 3.89 (3H, s), 3.93 (2H, bd s), 3.94 (2H, t, J=7), 4.01 (3H, s), 5.01 (2H, s), 6.30 (1H, bd s), 6.73 (1H, d, J=8), 6.90-7.33 (12H, m)

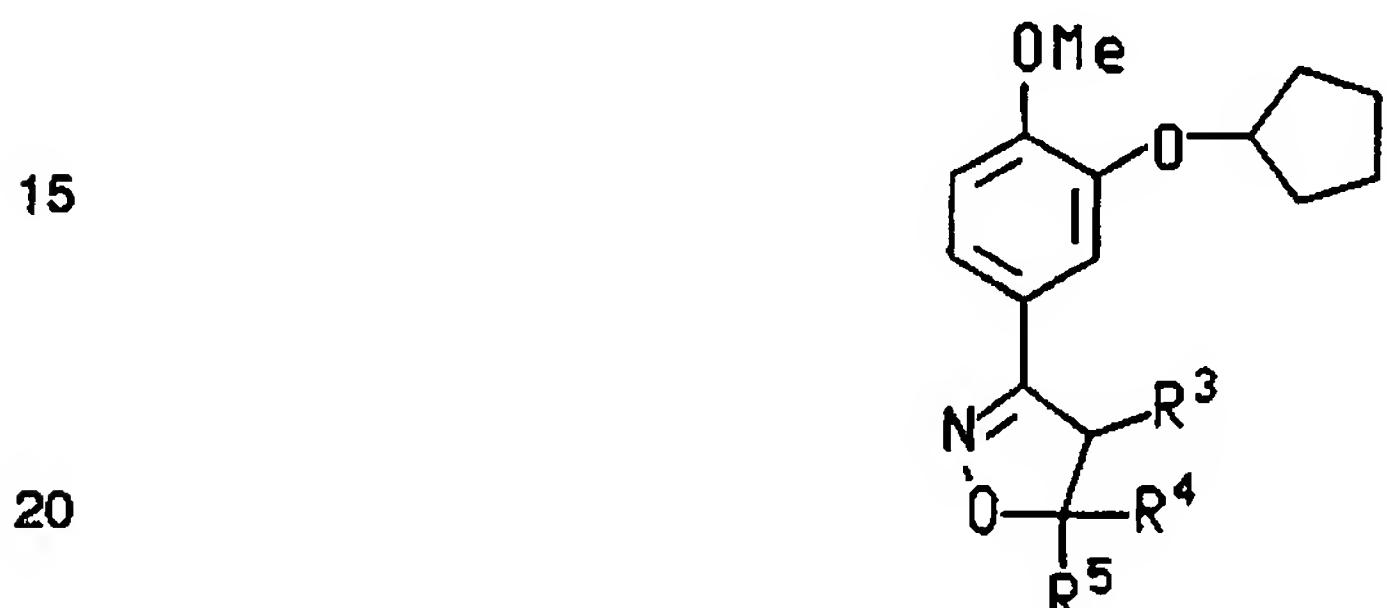
^a trans stereochemistry^b less polar diastereomer - R_f 0.23 (1:3 EtOAc-hexane)^c more polar diastereomer - R_f 0.16 (1:3 EtOAc-hexane)

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^d more polar diastereomer - R_f 0.42 (1:1 EtOAc-hexane)
^e less polar diastereomer - R_f .048 (1:1 EtOAc-hexane)
^f more polar diastereomer - R_f 0.42 (1:1 EtOAc-hexane)
^g diastereomers of examples 25 and 26 were separated by fractional crystallization
5 ^h less polar diastereomer - R_f 0.30 (3:7 EtOAc-hexane)
ⁱ more polar diastereomer - R_f 0.26 (3:7 EtOAc-hexane)

PREPARATIONS 31 - 32

The following compounds were prepared substantially according to the
10 procedure in Preparation 15 substituting the compound of Preparation 3 for the
compound of Preparation 1 and substituting the indicated olefin for ethyl acrylate.



25	Prep #	R ⁵	R ⁴	R ³	Olefin	M.P. °C	Data
	31	CO ₂ Et	H	H	Ethyl acrylate	oil	¹ H NMR (CDCl ₃): δ 1.27 (3H, t, J=7), 1.45–2.00 (8H, m), 3.56 (2H, d, J=10), 3.82 (3H, s), 4.22 (2H, q, J=7), 4.72–4.80 (1H, m), 5.09 (1H, t, J=10), 6.78 (1H, d, J=8), 6.98 (1H, d, J=8), 7.32 (1H, s)
30	32	CO ₂ Et	Me	H	Ethyl methacrylate	77-79	¹ H NMR (CDCl ₃): δ 1.25 (3H, t, J=7), 1.50–2.00 (8H, m), 1.63 (3H, s), 3.11 (1H, d, J=17), 3.78 (1H, d, J=17), 3.91 (3H, s), 4.18 (2H, q, J=7), 4.68–4.77 (1H, m), 6.75 (1H, d, J=8), 6.92 (1H, dd, J=8, 2), 7.27 (1H, d, J=2)

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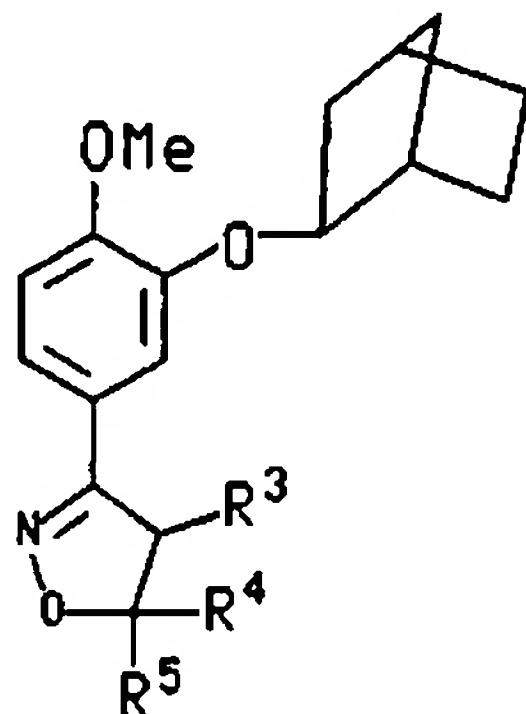
PREPARATIONS 33 - 34

The following compounds were prepared substantially according to the procedure of Preparation 15 substituting the compound of Preparation 4 for the compound of Preparation 1 and substituting the indicated olefin for ethyl acrylate.

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Prep. #	R ⁵	R ⁴	R ³	Olefin	M.P. °C	Data
20	33	CO ₂ Et	H	Ethyl acrylate	oil	¹ H NMR (CDCl ₃): δ 1.05–1.77 (8H, m), 1.27 (3H, t, J=7), 2.05 (1H, bd s), 2.43 (1H, bd s), 3.55 (2H, d, J=10), 3.92 (3H, s), 4.15–4.23 (1H, m), 4.21 (2H, q, J=7), 5.05 (1H, t, J=10), 6.77 (1H, d, J=8), 6.95 (1H, d, J=8), 7.25 (1H, s)
	34	(R)-CHNHCH-(Me)Ph	Me	H Cmpd of Prep 11 ^a	151-153	¹ H NMR (CDCl ₃): δ 1.10–1.75 (8H, m), 1.44 (3H, d, J=7), 1.65 (3H, s), 2.30 (1H, bd s), 2.50 (1H, bd d, J=4), 3.18 (1H, d, J=17), 3.81 (1H, d, J=17), 3.85 (3H, s), 4.21 (1H, d, J=7), 4.99–5.08 (1H, m), 6.83 (1H, d, J=8), 7.02 (1H, dd, J=8, 2), 7.12 (1H, d, J=9), 7.20–7.36 (6H, m)

25 ^a less polar diastereomer – R_f 0.4 (3:7 EtOAc-hexane)

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PREPARATION 35

3-[4-Methoxy-3-(5-phenylbutyloxy)]phenyl-2-isoxazoline-5-carboxylic Acid Ethyl Ester

The compound of this Preparation was prepared as an oil, substantially according to the procedure of Preparation 15, substituting the compound of Preparation 5 2 for the compound of Preparation 1. ^1H NMR (CDCl_3): δ 1.31 (3H, t, $J=7$), 1.74–1.94 (4H, m), 2.68 (2H, t, $J=7$), 3.57–3.61 (2H, m), 3.87 (3H, s), 4.03 (2H, t, $J=6$), 4.25 (2H, q, $J=7$), 5.12 (1H, t, $J=8$), 6.83 (1H, d, $J=8$), 7.03 (1H, d, $J=8$), 7.16–7.35 (6H, m).

PREPARATION 36

Dimethyl Propenyl-2-phosphonate

10 The title compound was prepared as described by the method of Benzra, et al. (Benzra, C.; Nseic, S.; Qurisson, G. Bull. Chem. Soc. Chim. Fr., 1967, 1140.)

Into a flask fitted with a reflux condenser was placed a mixture of 37 ml (29 g, 0.50 mol) of acetone and 46 ml (55 g, 0.50 mol) of dimethylphosphite followed by 3 ml of saturated methanolic sodium methoxide solution. A vigorous exotherm ensued and 15 the mixture was allowed to stir at RT for about 16 h. A large deposit of crystals formed and were filtered and washed well with ether-hexane (1:1) to give 50 g of dimethyl 1-hydroxy-1-methylethylphosphonate, mp 75–77°C.

A solution of 6.00 g (35.7 mmol) of dimethyl 1-hydroxy-1-methylethylphosphonate in 25 ml of pyridine was treated dropwise with 8.56 g (5.25 ml, 72.0 mmol) 20 of thionyl chloride. The mixture was allowed to stir for about 16 h at RT and the solvent was removed by evaporation. The residue was diluted with 200 ml of water and extracted with EtOAc (3 x 200 ml). The combined extracts were dried (Na_2SO_4) and evaporated to 4.12 g of a yellow oil which was purified by flash chromatography (100 g of silica gel) using EtOAc as eluant to yield 3.46 g of the title compound as an oil.

25 PREPARATION 37

Diethyl 2-Methyl-1-propenyl-3-phosphonate

A mixture of 5.0 g (0.037 mol) of methallyl bromide and 15 g (0.087 mol) of triethyl phosphite was heated to about 160°C for about 5 h. Purification of the crude reaction mixture by flash chromatography (300 g of silica gel) using an EtOAc-hexane 30 (3:2) eluant afforded 3.6 g (50%) of the title compound as a light yellow oil. ^1H NMR (CDCl_3): δ 1.31 (6H, t, $J=7$), 1.87 (3H, d, $J=3$), 2.56 (2H, d, $J=20$), 4.03–4.13 (4H, m), 4.82–4.92 (2H, m).

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PREPARATION 38

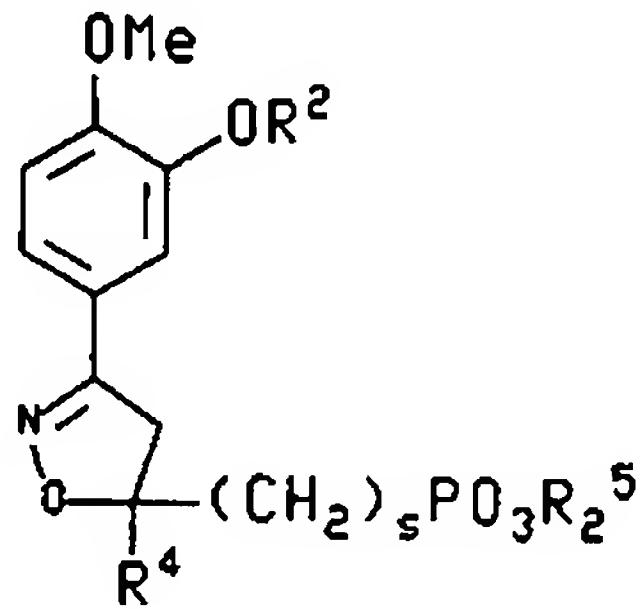
Diethyl 3-[4-Methoxy-3-(5-phenylpentyloxy)phenyl-2-isoxazolin-5-yl]phosphonate

To a mixture of 1.02 g (7.76 mmol) of N-chlorosuccinimide, 0.05 ml of pyridine, and 30 ml of CH_2Cl_2 was added 2.00 g (6.38 mmol) of the compound Preparation 1 in 5 10 ml of CH_2Cl_2 . The mixture was stirred for about 45 min at RT and 1.05 g (0.980 ml, 6.38 mmol) of diethyl vinylphosphonate was added followed by 0.777 g (1.07 ml, 7.66 mmol) of triethylamine. An exotherm ensued and the mixture became dark yellow. After stirring for about 2 h at RT, the mixture was diluted to 150 ml with CH_2Cl_2 and was washed with aqueous 1N HCl solution (2 x 100 ml), sat'd. aqueous NaHCO_3 solution 10 (2 x 100 ml), dried (MgSO_4), and evaporated to 3.75 g of a yellow oil. Purification by flash chromatography (150 g of silica gel) using successsively EtOAc-hexane (1:3), EtOAc, and MeOH- CHCl_3 (1:9) as eluants afforded 1.09 g of the title compound as an oil. ^1H NMR (CDCl_3): δ 1.30 (3H, t, $J=7$), 1.34 (3H, t, $J=7$), 1.40–1.90 (6H, m), 2.60 (2H, t, $J=7$), 3.52–3.65 (2H, m), 3.95 (3H, s), 3.99 (2H, t, $J=7$), 4.16–4.25 (4H, m), 4.80 (1H, 15 t, $J=12$), 6.80 (1H, d, $J=8$), 6.98–7.29 (7H, m).

PREPARATION 39 – 42

Reaction of the indicated oxime and olefin, analogous to the procedure of Preparation 38, afforded compounds having the following general structure:

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39. R^2 is $(\text{CH}_2)_5\text{Ph}$; R^4 is methyl; R^5 is methyl; s is 0; the oxime is the 30 compound of Preparation 1; the olefin is the compound of Preparation 36; M.P. 91–93°C; ^1H NMR (CDCl_3): δ 1.46–1.92 (6H, m), 1.64 (3H, d, $J=15$), 2.62 (2H, t, $J=7$), 3.18 (1H, dd, $J=17$ and 19), 3.75–3.88 (10H, m), 4.00 (2H, t, $J=7$), 6.83 (1H, d, $J=8$), 7.00 (1H, d, $J=8$, 2), 7.14–7.33 (6H, m).

40. R^2 is $(\text{CH}_2)_5\text{Ph}$; R^4 is H; R^5 is ethyl; s is 1; the oxime is the compound

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of Preparation 1; the olefin is diethyl allylphosphonate; ^1H NMR (CDCl_3): d 1.32 (3H, t, J=7), 1.34 (3H, t, J=7), 1.37-2.38 (8H, m), 2.61 (2H, t, J=7), 3.22-3.52 (2H, m), 3.86 (3H, s), 4.00 (2H, t, J=7), 4.06-4.18 (4H, m), 4.82-4.96 (1H, m), 6.82 (1H, d, J=8), 7.03 (1H, dd, J=2, 8), 7.13-7.33 (6H, m).

5 41. R^2 is $(\text{CH}_2)_5\text{Ph}$; R^4 is methyl; R^5 ethyl; s is 1; the oxime is the compound of Preparation 1; the olefin is the compound of Preparation 37; ^1H NMR (CDCl_3): d 1.30 (3H, t, J=7), 1.32 (3H, t, J=7), 1.28-1.90 (6H, m), 2.30 (2H, d, J=19), 2.61 (2H, t, J=7), 3.08 (1H, d, J=17), 3.63 (1H, d, J=17), 3.86 (3H, s), 4.00 (2H, t, J=7), 4.00-4.18 (4H, m), 6.82 (1H, d, J=8), 6.99 (1H, dd, J=2, 8), 7.11-7.32 (6H, m).

10 42. R^2 is cyclopentyl; R^4 is H; R^5 is ethyl, s is 0, the oxime is the compound of Preparation 3; the olefin is diethyl vinylphosphonate; ^1H NMR (CDCl_3): d 1.31 (3H, t, J=7), 1.35 (3H, t, J=7), 1.50-2.00 (8H, m), 3.56-3.67 (2H, m), 3.85 (3H, s), 4.17-4.25 (4H, m), 4.78-4.82 (2H, m), 6.83 (1H, d, J=8), 7.02 (1H, dd, J=2, 8), 7.32 (1H, d, J=2).

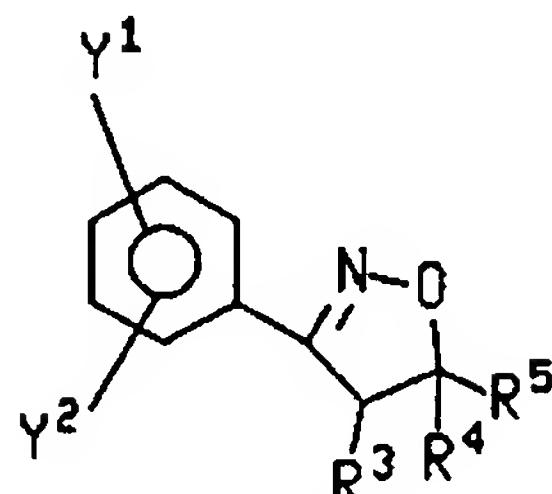
-39-

CLAIMS

What is claimed is:

1. A compound of the formula

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(I)

the racemic, racemic-diastereomeric mixtures and optical isomers of said compound and the pharmaceutically acceptable salts thereof wherein

Y¹ and Y² are independently selected from the group consisting of hydrogen, (C₁-C₆)alkyl, optionally substituted phenylalkyl having 1 to 6 carbons in the alkyl portion, optionally substituted phenoxyalkyl having 1 to 6 carbons in the alkyl portion, (C₃-C₇)cycloalkyl, fluoro, chloro, bromo, iodo, -OR¹ and -OR²;

wherein the aromatic portion of the optionally substituted phenylalkyl, and the aromatic portion of the optionally substituted phenoxyalkyl are optionally independently substituted with (C₁-C₄)alkyl, (C₁-C₄)alkoxy, halogen or CF₃;

R¹ is alkyl having 1 to 3 carbons, fluoromethyl, difluoromethyl or trifluoromethyl;

R² is (C₁-C₃)alkyl, (C₃-C₇)cycloalkyl, alkoxyalkyl having 3 to 7 carbons in the alkoxy portion and 2 to 4 carbons in the alkyl portion, optionally substituted phenoxyalkyl having 2 to 6 carbons in the alkyl portion, optionally substituted

phenylalkyl having 1 to 6 carbons in the alkyl portion, bicycloalkyl having 6 to 9 carbons or optionally substituted indanyl;

wherein the aromatic portion of the optionally substituted phenylalkyl, the aromatic portion of the optionally substituted phenoxyalkyl and the optionally substituted indanyl are optionally independently substituted with (C₁-C₄)alkyl, (C₁-C₄)alkoxy, halogen or CF₃;

R³ is hydrogen, (C₁-C₃)alkyl, mono-hydroxyalkyl having 1 to 3 carbons or alkoxyalkyl having 1 to 3 carbons in the alkyl portion and 1 to 3 carbons in the alkoxy portion;

R⁴ is hydrogen, (C₁-C₅)alkyl, -COOH, alkoxyalkyl having 1 to 3 carbons in the alkyl portion and 1 to 3 carbons in the alkoxy portion, N-alkylaminoalkyl having 1 to 3

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carbons in the alkylamino portion and 1 to 3 carbons in the alkyl portion or N,N-dialkylaminoalkyl having a total of 2 to 6 carbons in the dialkylamino portion and 1 to 3 carbons in the alkyl portion;

or R³ and R⁴ are taken together with the carbon atoms to which they are attached and

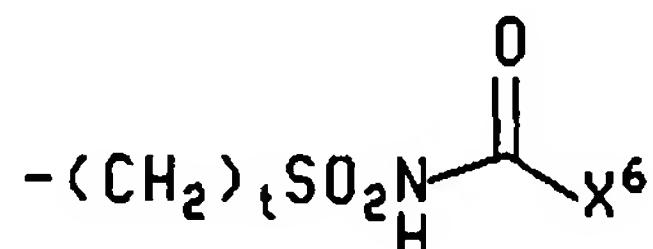
5 form -CH₂OCH₂OCH₂-; and

R⁵ is hydrogen, -CHO, amino, aminoalkyl having 1 to 3 carbons,



-COR⁷, -(CH₂)_mCO₂H, (C₁-C₄)alkyl, hydroxy, -(CH₂)_qCONX²X³, -(CH₂)_rSO₂NX⁴X⁵, -(CH₂)_sPO₃H₂ or

10



wherein b is 0 or an integer from 1 to 6;

m, n, q, r, s and t are independently 0, 1, 2, 3 or 4;

R⁶ and R⁷ are each independently (C₁-C₄)alkyl;

X¹ is hydrogen, (C₁-C₄)alkyl, -O(C₁-C₄)alkyl or alkoxyphenyl having one to four carbon atoms in the alkoxy portion;

15 X², X³, X⁴ and X⁵ are each independently hydrogen or (C₁-C₃)alkyl; and

X⁶ is (C₁-C₃)alkyl or phenyl;

provided that when R¹ is (C₁-C₃)alkyl, R² is (C₁-C₃)alkyl, R³ is hydrogen, and R⁴ is hydrogen then R⁵ is not -(CH₂)_sPO₃H₂; and

20 when R⁴ is -COOH then R⁵ is not -COOH; and that both Y¹ and Y² cannot be hydrogen at the same time.

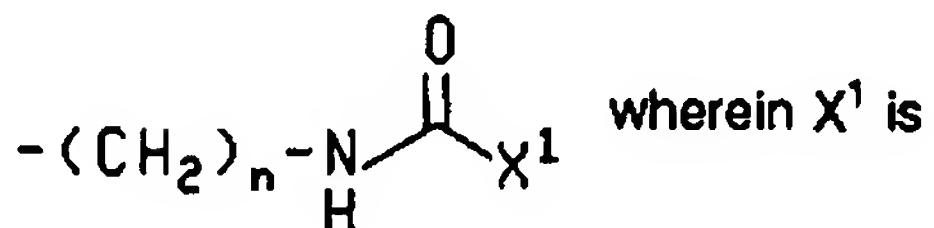
2. A compound according to claim 1 wherein Y¹ is -OR¹ and is attached to the 4-position of the phenyl ring and Y² is -OR² and is attached to the 3-position of the phenyl ring.

25 3. A compound according to claim 2 wherein R¹ is methyl; R² is (C₃-C₇)cycloalkyl, bicycloalkyl having 6 to 9 carbons, or phenylalkyl having 1 to 6 carbons in the alkyl portion; R³ is hydrogen or (C₁-C₃)alkyl; R⁴ is hydrogen or (C₁-C₅)alkyl and

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R^5 is $-(CH_2)_mCO_2H$, $-CHO$, $-COCH_3$, amino, hydroxy, mono-hydroxyalkyl having 1 to 3

carbons, aminoalkyl having 1 to 3 carbons, or



(C_1-C_4) alkyl or alkoxyphenyl having one to four carbon atoms in the alkoxy portion and n is 0 or an integer from 1 to 3.

- 5 4. A compound according to claim 3 wherein R^2 is cyclopentyl or phenylalkyl having 4 or 5 carbons in the alkyl portion.
- 5. A compound according to claim 4 wherein R^2 is 5-phenylpentyl.
- 6. A compound according to claim 5 wherein R^5 is $-(CH_2)_mCO_2H$, $-CHO$, $-COCH_3$, hydroxy or mono-hydroxyalkyl having 1 to 3 carbons.
- 10 7. A compound according to claim 6 wherein R^5 is $-(CH_2)_mCO_2H$.
- 8. A compound according to claim 7 wherein R^3 is hydrogen; R^4 is hydrogen or (C_1-C_5) alkyl and $m=0$.
- 9. A compound according to claim 8 wherein R^4 is hydrogen, methyl, ethyl or propyl.
- 15 10. A compound according to claim 9 wherein the compound is (+) or (-)-5-ethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]-phenyl-2-isoxazoline-5-carboxylic acid.
- 11. A compound according to claim 10 wherein the compound is (-)-5-ethyl-3-[4-methoxy-3-(5-phenylpentyloxy)]phenyl-2-isoxazoline-5-carboxylic acid.
- 20 12. A compound according to claim 1 wherein R^1 is CH_3 ; R^2 is 5-phenylpentyl; R^3 is hydrogen; R^4 is hydrogen or CH_3 and R^5 is $-(CH_2)_sPO_3H_2$ wherein s is 0 or 1.
- 13. A compound according to claim 1 wherein R^1 is CH_3 ; R^2 is cyclopentyl; R^3 is hydrogen; R^4 is hydrogen and R^5 is $-(CH_2)_sPO_3H_2$ wherein s is 0.
- 25 14. A pharmaceutical composition comprising an amount of a compound according to claim 1 and a pharmaceutically acceptable diluent or carrier.
- 15. A method of inhibiting phosphodiesterase type IV in a mammal in need thereof which comprises administering to said mammal a phosphodiesterase IV inhibiting amount of a compound according to claim 1.
- 30 16. A method of treating an inflammatory condition in a mammal in need thereof which comprises administering to said mammal an antiinflammatory amount of a compound according to claim 1.

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17. A method of treating AIDS, asthma, arthritis, bronchitis, chronic obstructive pulmonary disease, psoriasis, allergic rhinitis, dermatitis or shock in a mammal in need thereof which comprises administering to said mammal an effective amount of a compound according to claim 1.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 94/00313

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 6 C07D261/04 A61K31/42 C07D498/04 C07F9/653

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 6 C07D C07F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,92 03053 (HOECHST AKTIENGESELLSCHAFT) 5 March 1992 see page 19 - page 23; claims ---	1
X	US,A,4 889 551 (KENGO ODA ET AL) 26 December 1989 see the whole document ---	1
A	WO,A,87 06576 (PFIZER INC.) 5 November 1987 cited in the application see page 25 - page 29; claims 1,70 ---	1,14-17
A	WO,A,93 07141 (SMITHKLINE BEECHAM CORPORATION) 15 April 1993 see page 2, line 1 - page 4, line 3; claims 1,6-9 ---	1,14-17
		-/-

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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'&' document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

25 November 1994

- 6. 12. 94

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.
Fax: (+31-70) 340-3016

Authorized officer

Henry, J

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 94/00313

C(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 313 997 (HOECHST AKTIENGESELLSCHAFT) 3 May 1989 cited in the application see claims -----	1,14-17

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IB 94/00313

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		CA-A-	1329604	17-05-94
		DE-D-	3888284	14-04-94
		JP-A-	1146887	08-06-89
		US-A-	5006515	09-04-91
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